Volume 9, No. 3 **May, 1954**

Technical Services for Soil and Water Conservation
. . . EZRA T. BENSON

Some Physical Facts About Connecticut Soils
. . . C. L. W. SWANSON

Contour Furrows on Pasture and Range Land
. . . C. D. BREHM AND H. E. MALMSTEN

Wanted: Factual Data for Evaluating the Effect of Water Conservation Programs on the Land
. . . LLOYD L. HARROLD

Book Reviews: The Flood Control Controversy; Grasses and Grassland Farming; Our Wildlife Legacy; Conservation Law and Administration and others.

New Holland's new "66" P.T.O. bales up to 7 tons an hour with a 2-plow tractor

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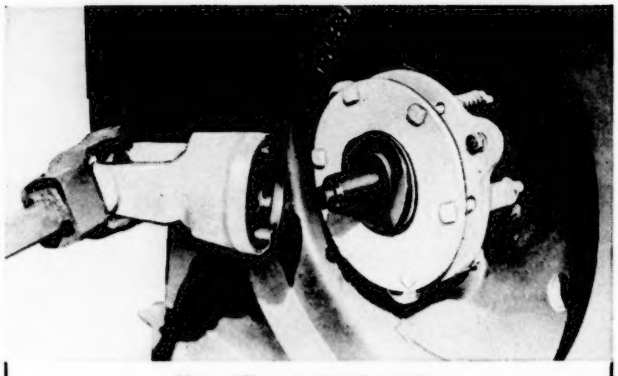

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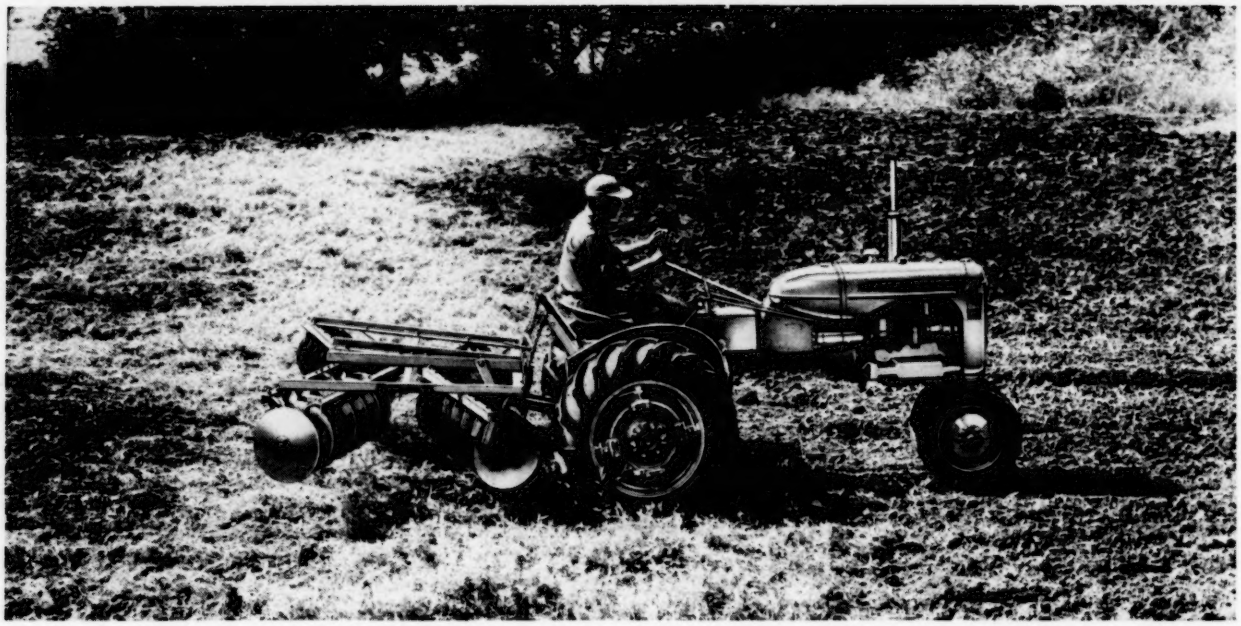

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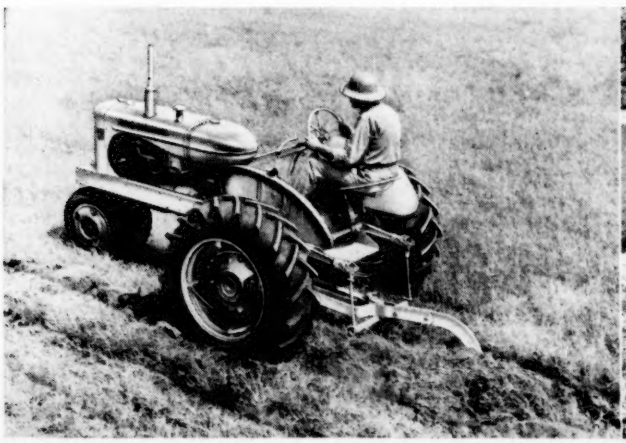

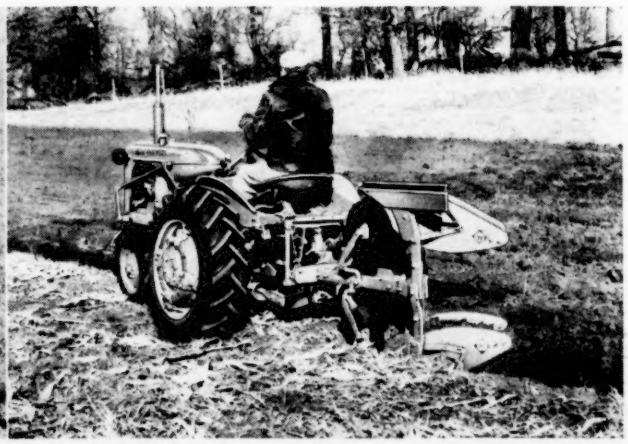

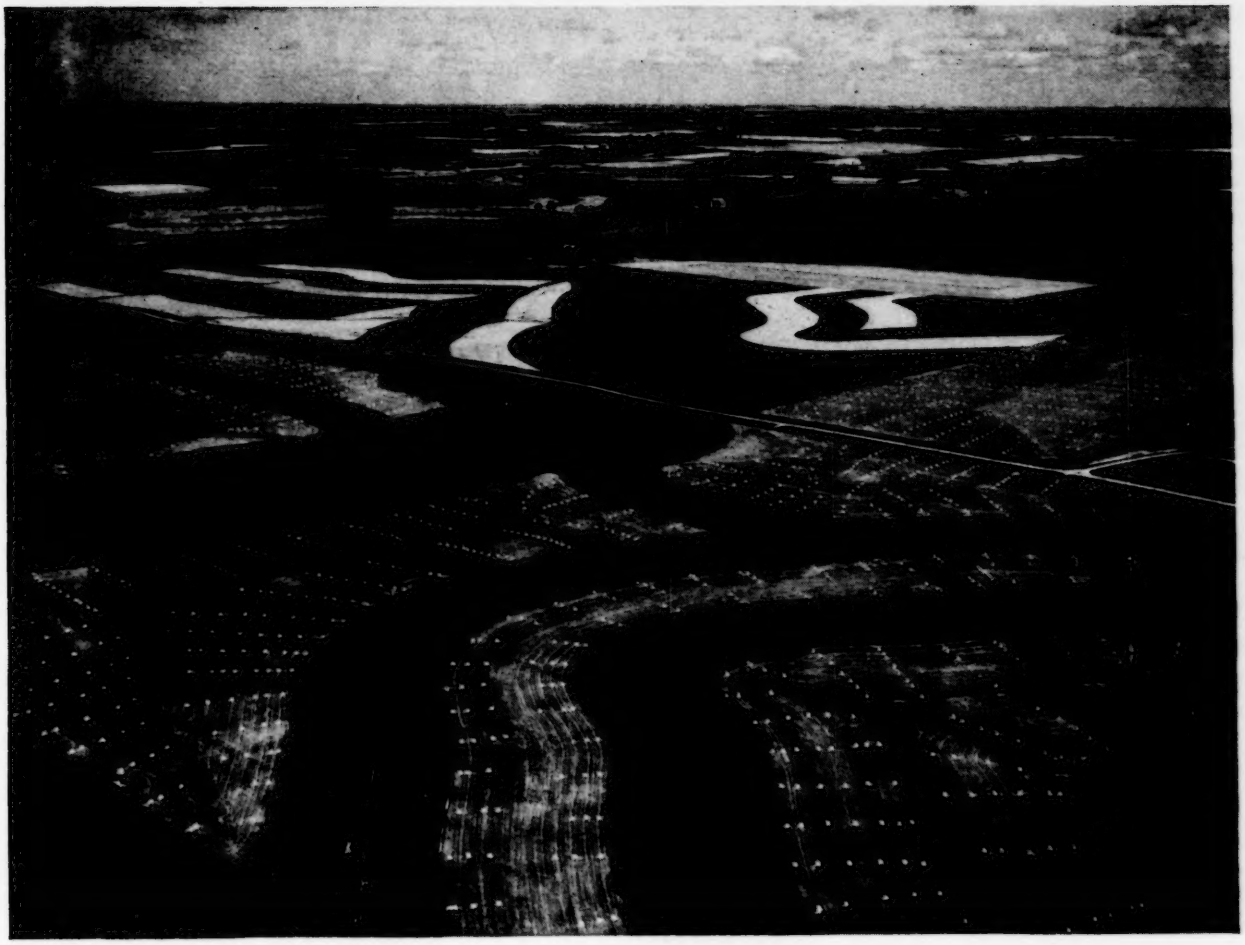

The shape of our future

Almost every year a specter of human misery and tragic waste visits us . . . as we see natural resources destroyed by drought, flood, erosion.

Must it be that way?

Of course not. We can shape the future through application of research . . . through balanced conservation practices . . . through wise use of the right kind of farm machinery and equipment.

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Journal of SOIL AND WATER CONSERVATION

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This JOURNAL is the official organ of the Soil Conservation Society of America. It is owned, edited, and published bi-monthly by the Society.

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COVER: This shows how wheat breaks up each pelting raindrop—thereby reducing a downpour to a gentle, helpful rain.

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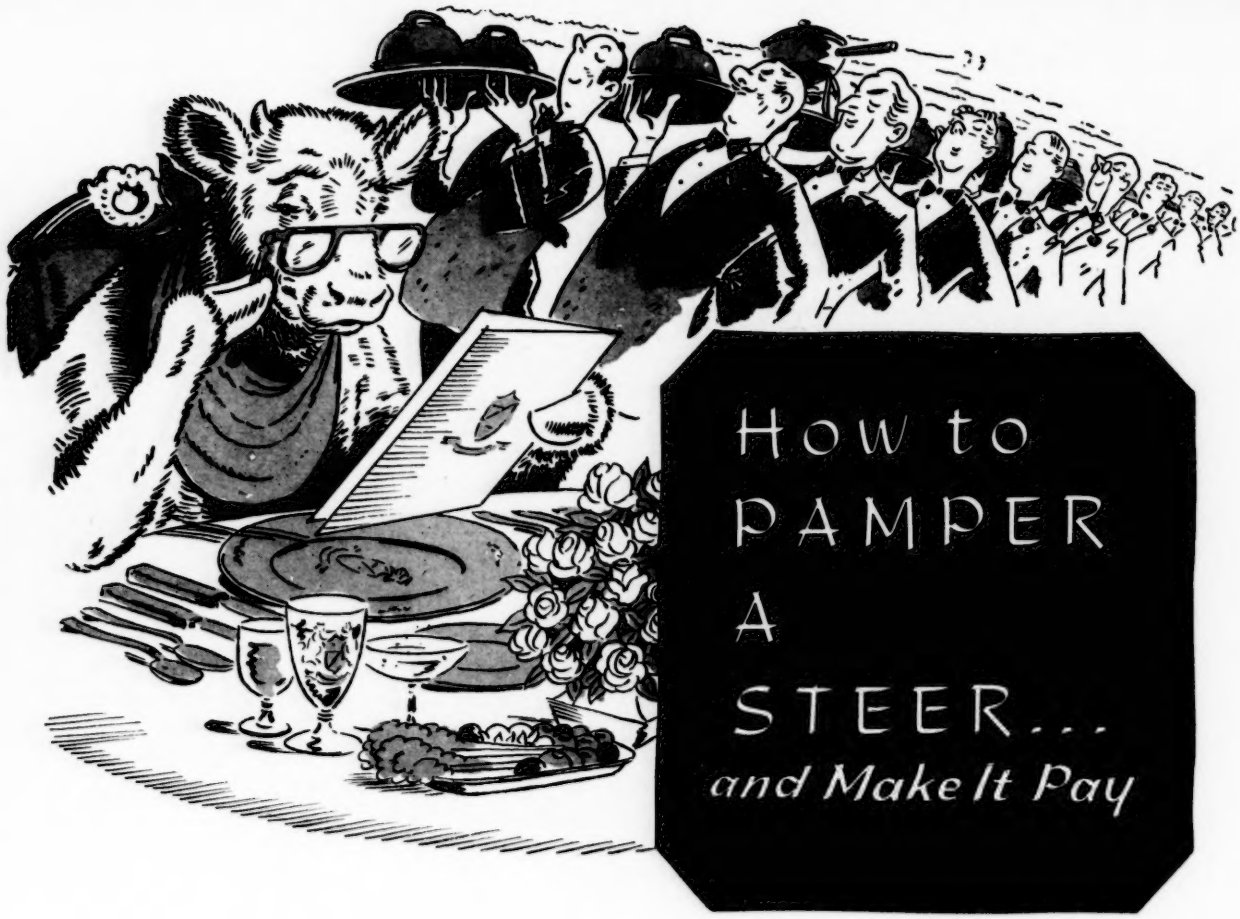

How to PAMPER A STEER... and Make It Pay

MAYBE it's true that Buster here doesn't know *table d'hote* from *a la carte,* but don't let that fool you. He really knows his "vittles," as anyone who has tossed a shank over a pasture fence can tell you.

Fact is, in his own four-footed world Buster ranks as quite the *gourmet,* and he's been known to get downright fussy at times. That's why those who know him best—cattlemen, that is—have come up with some pretty tasty recipes to satisfy his boyish appetite—to help him grow into a stout, healthy young fellow that will make a good impression on "graduation day," when Buster is shrewdly judged in terms of steak.

And because feeding Buster has become such a science, often special machinery is required—like the new John Deere Grassland Drill, which is making such a hit with livestock growers. You see, the John Deere Grassland Drill makes it possible to establish and improve range and grassland and keep Buster supplied with the wholesome, nutritious food he likes and needs.

Buster, of course, generously pays back such treatment in more pounds of better beef—all because he doesn't have to take the "potluck" fare of poor pasture.

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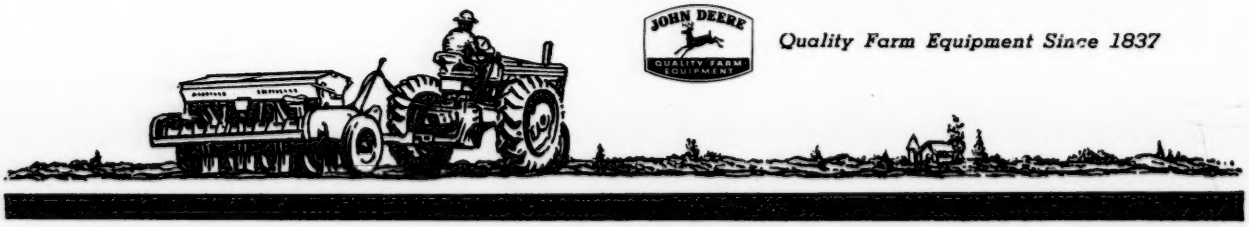


Technical Services for Soil and Water Conservation

EZRA TAFT BENSON

In this article, Mr. Benson emphasizes three main resource-conservation jobs ahead. They are: to accelerate both research and education, to improve technical aid to landowners and operators and to encourage local leadership such as is provided by soil conservation districts, community and neighborhood teams. He also includes in this, the planning and treatment of entire watersheds.

Mr. Benson further points out that "The reorganization of the Service in no way changes the job of the Soil Conservation Service, its objectives, or its underlying philosophy of the treatment and use of land according to the land's needs and capabilities. The new setup provides for continuation and speeding up of all technical functions of the Service."

Ezra T. Benson

IN THE STATEMENT on agricultural policy which I issued on February 5, 1953, I pointed out that one of the primary objectives of agriculture is to improve the productivity of basic land resources. To achieve that objective, we must have a dynamic national program in soil and water conservation.

My belief in soil conservation is deep-seated. As a farm boy, I learned firsthand the enormous menace of erosion from the watershed that lay above our land in the Cache Valley in southern Idaho. Since then, I have seen conservation problems and progress all over America. I believe sincerely in soil conservation with all my heart and my soul.

The soil, water, range, and forest resources of the United States are the natural foundation of our national economy. From them come our food, most of our clothing, and much of our shelter. How well we protect and improve these resources will have a direct bearing on the future standards of living of the whole nation.

Just now, when we are hearing so much about agricultural surpluses, we need to keep our perspective clear. We need to look ahead as far as we can and try to foresee the demands likely to be placed on the nation's physical agricultural plant.

The demands upon agriculture are certain to grow heavier in the years ahead. The population of the United States is increasing at a most rapid rate. Estimates of the demands 25 years from now range 25 to 40 per cent greater than current production. It is conceivable, and even probable, that less than a century from now the soils of this country will need to support a population double that of today.

Ezra Taft Benson is Secretary of Agriculture, United States Department of Agriculture, Washington, D. C.

We do not have enough new land to draw on in this country to meet the expanding needs of the future. To meet rising demands, we shall have to depend mainly on increasing the per-acre yields on our crop and pasture land, and on our range and forest lands. But our land resources are adequate to our needs for a long time to come, provided we care for them properly.

The national interest demands that the application of soil and water conservation be speeded up on the farms and ranches and on the watershed, grazing, and forest lands throughout the United States. President Eisenhower recognized this in July, 1953, when he sent a special and forceful natural resource conservation message to the Congress. He gave us a theme for this era when he said *"conserving and improving our land and water resources is high priority business for all of us."*

We want the agricultural producers a generation from now to be able to say that we in this generation made provision for conservation of our agricultural resources and for the research and education needed to make the conservation efforts effective and sound.

Fortunately, during recent years, we have learned much about how to protect and improve the land. We have learned a great deal about the causes of soil, watershed, forest, and range deterioration. We have learned a great deal about methods to combat these problems and I believe we have a sound conservation approach.

A few months ago we got out a little green-covered booklet entitled *"Strengthening American Agriculture Through Resource Conservation."* In it we said that modern conservation involves proper land use, protecting the soil against erosion and other forms of deterioration, correcting deficiencies of lime and plant nutrients, and rebuilding eroded and depleted soils. It also means protecting and improving forests and farm woodlands and improving grasslands. It includes conserving moisture

Figure 1. A Soil Conservation service farm planner discusses complete farm plan with two farmers.

for crop use, reducing flood and sediment damage, improving the quality and regularity of water yields, installing proper agricultural drainage and irrigation, and increasing crop yields and income—all at the same time.

Modern soil and water conservation further includes the planning and treatment of entire watersheds. That job is to gear together the management of crop, range, and forest lands, and the treatment of water courses in the upper watersheds to minimize the damage of floods and sedimentation, and to improve the quality and regularity of water supplies.

In conserving the nation's soils and protecting the agricultural land from floods, individual farmers and local communities must play the primary role. But, for them to get the job done, it is imperative that they have the best possible information, guidance, and assistance.

We believe that a dynamic national program of research, education, technical assistance, and where needed, cost sharing in soil and water conservation is one of the basic necessities of American agriculture. It is the policy and the firm intention of the Department of Agriculture to discharge fully its part of that responsibility.

But the final responsibility for carrying out a sound, vigorous program of conservation rests with the people who own and operate the land. A national conservation program, however urgent its need, cannot have force in a democracy unless it is accepted as the individual responsibility of the man who uses and manages the resources.

It is the policy of the Department of Agriculture to encourage and aid farmers and ranchers to pland and apply conservation farming measures, but to do for them only those things which need to be done in the public interest and which local people cannot do for themselves. We believe that people who own and operate the land will accept the responsibility if they are fully informed and are provided with the kind and amount of assistance needed to supplement their own knowledge and resources.

We have learned from experience that the success of soil conservation programs depends upon local responsibility and leadership. It is the millions of good decisions on individual farms and in thousands of local communities that add up to progress in soil conservation.

The soil conservation district has proved to be an effective mechanism through which local responsibility and leadership in soil and water conservation can be assumed and local needs and desires can be made known. Because districts are local units of state government, organized and controlled by local people, we consider them an effective device through which the government can serve farmers without dominating them.

Now, let us glance briefly at various activities of the department which are directly related to soil and water conservation problems.

As you know, the department is carrying on a wide variety of research projects dealing with soil and water conservation. This work is scattered throughout the nation where the problems exist, and most of it is conducted cooperatively with State Agricultural Experiment stations.

Recently we have consolidated all soil and water research projects in the Agricultural Research Service under a new branch, "*Soil and Water Conservation Research.*" Here investigations on such problems as fertilizer improvement, soil management, irrigation, drainage, infiltration, sedimentation, and the hydraulics of water can be coordinated in one unit so as to find more quickly the solutions to the complex problems that exist throughout the country. We hope to be able to strengthen further this important phase of research.

We have arranged for a close integration of soil and water conservation research with investigations in the economics of farm management, agricultural engineering, and crop improvement closely related to the conservation problem. At the same time, improved methods are being provided for channeling research results to the technical workers of the Soil Conservation Service and other agencies dealing with the conservation problem. We look on research in this area as a key part of our total conservation effort.

Another important and necessary part of the department's conservation activities is that of assembling, training, and directing in the Soil Conservation Service the work of a corps of technicians who are skilled in the science and application of soil and water conservation.

In assisting farmers and ranchers with their land and water problems, the Service uses four principal procedures. *Technical assistance* begins with an acre-by-acre

Figure 2. Technology of land use and soil treatment must be fitted specifically to the individual farm or ranch. This contour peach orchard and diversion terrace is on a farm in eastern Pennsylvania.

soil survey—a scientific inventory of soil and water resources. The Soil Conservation Service is responsible for meeting the soil survey needs of all agencies concerned with land use and conservation.

Second, the technician and landowner together draw up a conservation farm plan designed to fit the soil and water resources of the particular farm or ranch. This plan provides for various alternatives in the treatment and use of the land according to its needs and capabilities, as indicated by the survey.

The *third* step involves the application of practices called for in the plan. The soil conservationist gives technical help in establishing water control systems and stockwater developments, drainage systems, terracing, contour stripcropping, pasture and range improvement and management, farm woodland practices, and measures benefiting wildlife.

And *finally*, the Service provides any specialized guidance that may be needed for maintaining the farm conservation system after it is applied on the land.

The nation's stake in conservation of soil and water is clear, but the job is difficult because the technology of land use and soil treatment must be fitted specifically to the individual farm or ranch as well as to the resources and aptitudes of the farmer himself. The problems differ from farm to farm and field to field.

In recent months the department has taken steps to improve its conservation services. Our purpose in reorganizing the Soil Conservation Service was to enable it to serve farmers better by getting more conservation work applied to the land more effectively. We are strengthening the Service by strengthening its state offices and by making straight-line administrative responsibility to each state office from the Washington office. The State Soil Conservation Service offices are being given greater responsibility for program formulation and execution. We believe the result will be that farmers and ranchers will receive a larger proportion of each conservation dollar.

The plan also strengthens the technical staff of each of the state offices of the Soil Conservation Service. The typical Soil Conservation Service headquarters in each state will be staffed by the State Conservationist and Deputy State Conservationist, a conservation engineer, a state soil scientist, a soil conservationist and a state administrative officer with necessary business aids.

In addition, subject matter specialists (engineering and watershed planning specialists, plant technologists, and cartographic field units) each serving a group of states, are located strategically throughout the United States to provide scientific and technical guidance and training, and for production of soil maps, farm plans, and other essential working materials.

The reorganization of the Service in no way changes the job of the Soil Conservation Service, its objectives, or its underlying philosophy of the treatment and use of land according to the land's needs and capabilities. The new set-up provides for continuation and speeding up of all technical functions of the Service.

Figure 3. Building organic matter into the soil is a basic part of a soil and water conservation program.

A new activity recently begun in the Department of Agriculture is the watershed protection program, which combines measures for soil and water conservation and upstream flood prevention. The Congress has directed that cooperative programs of this type be undertaken in designated small watersheds widely situated throughout the country.

The primary purpose of this program is to demonstrate the physical and economic benefits of soil and water conservation and upstream flood prevention and to determine ways and means for providing more effective local-state-federal cooperation in planning and carrying out watershed protection programs.

Special types of technical skill are required to make scientific land inventories that clearly define the capabilities, the conservation needs, and the flood-prevention devices and practices for these watersheds. Leadership for this activity has been assigned to the Soil Conservation Service, with responsibility for the work in the national forests delegated to the Forest Service.

Local people and local organizations, especially soil conservation districts, play a very important part in this watershed protection program. Before the work can proceed, local people must indicate their willingness to sponsor the program, to provide necessary local guidance and leadership, and to share the costs. Operations already are under way on more than 60 of the watersheds. The work in all of them is scheduled to be completed within five years.

Another departmental activity in soil and water conservation is concerned with educational assistance. Conservation education is a fundamental step toward the application of conservation measures on the land. We need it to inform farmers and ranchers about the principles and practices involved in soil and water conservation and in relating conservation measures to the other features of good farm management.

The Federal and State Extension Services shoulder the department's primary responsibility for the educational phase of the soil and water conservation program. The better the education job that is done by the Extension Services, the more effectively the Soil Conservation Service will be able to provide farmers with technical assistance. And the better the job of technical assistance done by the Soil Conservation Service, the more the farmer can capitalize on a good program of education in the broad field of farm management.

Modern conservation means treating the land according to its needs and capabilities. It is a job for the people who *use* the land—assisted by adequate technical and other necessary aid from the government in getting the job done.

The Department has three main objectives in its coordinated soil and water conservation program:

1. To accelerate both research and education for conservation, so as to improve our agricultural resources;

2. To improve technical aid to landowners and operators and help speed up the survey of soil resources and the planning and application of needed conservation measures;

3. To pursue a policy of encouraging local leadership such as is provided by soil conservation districts, watershed organizations, and other community and neighborhood groups.

In the furtherance of these objectives we are anxious to work with the conservation districts, as we are with every agricultural group in America. We want all agricultural groups to look on the department as *their* department, as a great service organization maintained by the people for the benefit of the people. We are determined to make the department as efficient and effective as it is humanly possible to make it.

We seek advice and counsel—your advice and your counsel. We need it. We believe in it. We welcome it. Let us all move forward together to serve agriculture.

By working together, we can strengthen our total effort directed toward establishment of a permanent type of agriculture. With the help of Providence, we can move forward with a dynamic program to preserve and improve our God-given natural resources.

Contour Furrows on Pasture and Range Land

C. D. BREHM and H. E. MALMSTEN

Contour furrows were plowed on thousands of acres of western range land during and immediately following the great drought of the "thirties."

Overgrazing and drought combined had greatly reduced or eliminated the soil-protecting mantle of grass. These conditions and the resultant accelerated runoff and erosion created a need for conservation practices that would hold water on the land. Contour furrows were found to be one of the effective practices for this purpose on range and pasture land.

THE EARLY LAYOUT and construction of contour furrows varied considerably because of a lack of research on the effects of furrows on both vegetation and runoff. Since then, research findings and field observations have exerted their influence on the use, layout and construction of contour furrows.

In the Northern Great Plains states of Kansas, Montana, Nebraska, North Dakota, South Dakota and Wyoming, grasslands are contour furrowed for one or both of the following inter-related purposes:

(1) To reduce runoff for the protection of lower lying lands or facilities from overflow and siltation. Contour furrows intercept and hold much runoff water at its source, encourage infiltration, and can spread excess water from rain or snowmelt in a non-erosive manner (Figure 1).

(2) To store runoff in order to provide additional moisture for the growth of grasses. Where the surface soil is sparsely covered with vegetation as a result of drought or overgrazing, the runoff rate is high and the infiltration rate is low. The use of contour furrows on such areas can increase the storage of moisture in the soil. This favors the establishment and growth of grasses.

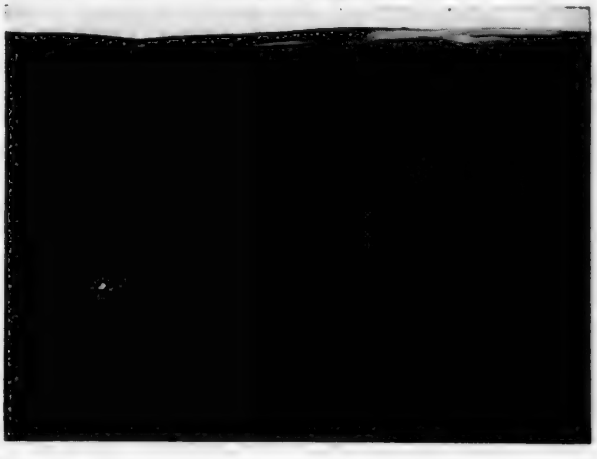
For both purposes, contour furrows have been restricted to fairly uniform slopes of 20 per cent or less, where the soil material is 10 inches or more in depth, and where there are few rocks or other materials that would interfere with construction. Light-textured soils are not furrowed, because the infiltration rate for water is high and the runoff rate is low.

Contour furrows are one of the several mechanical and vegetative conservation practices used in the treatment of range and pasture land on which there is significant runoff. A practice somewhat similar to contour furrowing is "*pitting*." Research data, however, have generally shown slightly greater benefits from furrows (1). Furthermore, contour furrows are more adaptable in designing for control of runoff, and experience indicates that their layout and construction costs are comparable to pitting costs.

The trend in contour furrowing has been toward smaller furrows with narrower spacings. When they were first widely used, the furrows were made 12 inches or more in width and spaced 20 to 50 feet apart. Natural revegetation was depended upon to reestablish a plant cover in the furrows and on the excavated materials.

The large furrows or channels, with their high dirt ridges immediately below them, gave uneven distribution of the water and caused considerable overtopping. Travel across the area was very difficult. The dirt ridges smothered the buried grass and encouraged weed growth for a few years until grass again reoccupied the area. Small furrows with narrow spacings minimize the objectionable features and give increased vegetative and water erosion control benefits. These beneficial effects are substantiated by Soil Conservation Service research.

Figure 1.—Contour furrows spaced 42 inches apart used to hold and spread runoff water from terraces that outlet on a pasture on the Herb Siecke farm in Sherman County Soil Conservation District, Nebraska. These contour furrows were constructed in June 1949 and photographed in May 1950.



C. D. Brehm is an engineer in the South Dakota State Office of the Soil Conservation Service at Huron. He was formerly a zone conservationist in engineering in the Northern Great Plains Region.

H. E. Malmsten is zone conservationist for the Soil Conservation Service with headquarters at Lincoln, Nebraska. He has been associated with range and engineering problems in the Northern Plains Region for many years.

Research data on the effects of furrowing and pitting on grassland have been published by O. K. Barnes, at the Archer Field Station, Cheyenne, Wyoming. (1) (3). This research was conducted over a 10-year period on sandy loam soils, on one to eight per cent slopes with a cover that was predominantly blue grama and western wheatgrass. In this experiment, the contour furrows were five inches wide by four inches deep, with two foot spacings. The pits were of a size made by an eccentric disc with 18 inch discs, two inches off center, spaced 16 inches apart. Tables 4 and 5 of this research report indicate the following results for the 10-year period:

1. Pasture treatment provided 22 per cent more sheep days of grazing than no treatment.
2. Contour-furrowed and pitted pastures increased the lamb gain 25 per cent and 19 per cent, respectively, over no treatment.
3. The pounds of grass left at the end of the grazing season on contour-furrowed and pitted pastures were 52 per cent and 25 per cent, respectively, over no treatment.
4. Grass residues left on the contour-furrowed pastures exceeded those on the pitted pastures by 21 per cent.

Soil Conservation Service research at the Central Great Plains Experimental Watershed near Hastings, Nebraska, shows pertinent hydrological data on rainfall runoff and the effect of contour furrowing on runoff from native grass areas. (2) (3). These studies were made on slowly to moderately permeable soils of medium texture, with seven per cent slopes and a midgrass type of vegetation. The first six years of this experiment compared the runoff from pastures with and without contour furrows, and with light and heavy grazing use. The furrows were four inches deep, six inches wide and spaced at 10 to 18 feet. The experiment was revised after six years of study in order to determine the effects of contour furrows and pitting on the amount of runoff from moderately grazed pastures. Results covering four years of the revised experiment, during which the average annual rainfall was 21.92 inches, are:

Pasture Treatment	*Average Annual Runoff (Inches)*
None	1.19
Eccentric disced on the contour	0.59
Contour furrowed, 12-18 foot spacing	0.19
Contour furrowed, 4-5 foot spacing	0.07

The results from ten years of experimentation indicate the following:

1. The runoff from conservatively grazed pastures was about 50 per cent less than from those heavily grazed, where none of the pastures had mechanical treatment.
2. Conservative grazing plus furrows (four to five feet apart) reduced total annual runoff by 90 per cent or more.
3. The total runoff from furrowed pastures, conservatively grazed, was 0.3 of one per cent of the total annual rainfall.

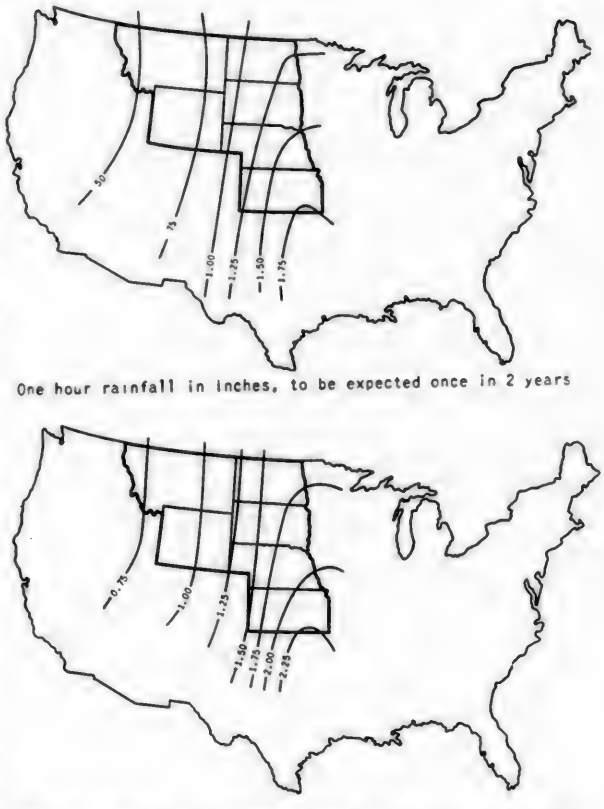


Figure 2. Rainfall intensity frequency curves for the northern Great Plains States.

The results of the experimental work at both the Archer Field Station and the Hastings Hydrologic Station indicate that furrows six inches or less in depth and width and spaced from two to five feet apart are effective both in increasing forage and in controlling runoff.

A combination of furrow size and spacing interval can be designed in the same manner as the spillway for a dam by using pertinent rainfall data and estimating runoff conditions. For the area to be furrowed, the rainfall intensity in inches per hour is determined for a two- or five-year frequency storm (Figure 2). A one-hour storm with a five-year frequency has been used when the watershed area to be furrowed lies above a critical area (farmstead, irrigation ditch, deep gullies, etc.) and a two-year

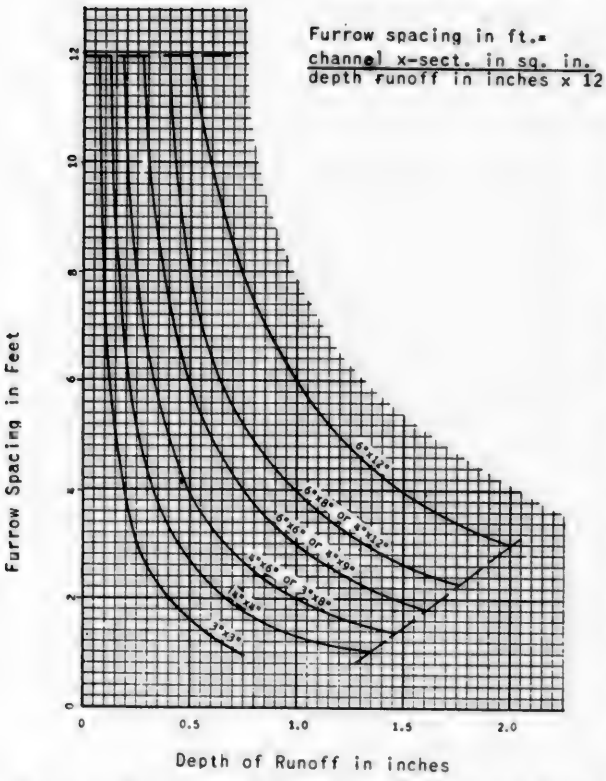


Figure 3. Spacing of contour furrows of varying channel capacity for different depths of runoff.

frequency rainfall intensity elsewhere. From this rainfall intensity, an estimate is made of the amount of rainfall that will be runoff. This is done by selecting a runoff coefficient from engineering handbooks that reflects the influence of slope, soil permeability, and vegetal cover characteristics of the watershed. The runoff coefficient may vary from 0.20 to 0.80 in the Northern Great Plains states, dependent upon conditions. The determined rainfall intensity, in inches per hour, multiplied by the runoff coefficient gives the expected runoff in inches per hour. The furrow spacing needed for storing various amounts of runoff then can be determined from the spacing chart (Figure 3). It can be seen that, for a runoff of 0.6 inch per hour, any of the following furrow sizes and spacings can be utilized.

3″ x 3″ (depth x width)	1.3 feet apart
4″ x 4″ (depth x width)	2.2 feet apart
4″ x 6″ or 3″ x 8″	3.3 feet apart
6″ x 6″ or 4″ x 9″	5.0 feet apart
6″ x 8″ or 4″ x 12″	6.4 feet apart
6″ x 12″	9.9 feet apart

The purpose for which contour furrows are constructed and the amount of runoff to be intercepted largely determine the selection of furrow size and spacing. If vegetative response is desired, furrows six inches or less in width with two- to five-foot spacings are used. If reduction of runoff is the primary purpose, larger furrows with wider spacing may be selected. The equipment which the operator has available also may influence the selection of the size and spacings of contour furrows.

Contour furrows are laid out and constructed so they are level and have closed ends (Figure 4). The excavated dirt is broken up and spread between them to eliminate the formation of ridges at the lower sides.

Cultivators, modified listers, and toolbar machines equipped with small shovels will make the desirable type of contour furrows (Figure 5). The furrowing machine needs to be strong to withstand the speed and heavy pull in cutting sod. It should be equipped with rolling coulters and devices to tousle the sod and waste it above and below the excavated furrow. The operator should be able to lift and lower the furrowing tools quickly so that the furrows are stopped short of rills, roads, or drainageways. Harrows and packers have been used to break up the sod chunks after the furrows are constructed.

Any season of the year is suitable for furrow construction, if the ground is not too dry or frozen. The best construction time, however, is in early spring or late fall when vegetation is dormant and cultivated fields are too wet to work. Furrows made in the spring are more easily revegetated than those made in the summer.

Natural revegetation occurs quickly only on grassland

Photo by Soil Conservation Service

Figure 4.—Contour furrows constructed in June 1948 on the Vernon Adams farm in Sheridan County Soil Conservation District, Kansas and photographed three months later.

that has well distributed rhizomatous or stoloniferous species. In the absence of such species and to hasten revegetation of the furrows, legumes and grasses should be seeded at the time of construction. Any seeding equipment that will scatter seed in the bottom of the furrow is satisfactory. Loose soil, plant fragments and runoff in the excavation provide a good medium for seed germination.

Furrowing costs per acre are comparable to plowing costs in many cases. Consequently, water-storage costs by this conservation practice are very reasonable. Many small earth dams do not hold more than one acre-foot of water for each 300 to 400 cubic yards of fill. If earth fill costs are 15c per cubic yard, water storage costs are $45.00 per acre-foot, or more. Large and expensive dams, located on main tributaries, have costs of $50.00 or more per acre-foot of storage.

The storage potential of contour furrows for any furrowed acreage and with any spacing and furrow size can be determined by the following formula:

$$V = \frac{w \times d \times A}{s}$$

Where V = Volume of water in acre-feet
w = width of furrows in feet
d = depth of furrows in feet
A = area furrowed in acres
s = horizontal spacing of furrows in feet

For example: Furrows 4 inches by 4 inches, spaced 5 feet apart will hold the following amount of water on 45 acres:

$$V = \frac{0.33 \times 0.33 \times 45}{5} = 1.00 \text{ acre-foot}$$

If furrowing costs approximate $1.00 per acre, the cost per acre-foot of water storage in these furrows would be $45.00. This cost compares well with storage costs for dams.

Contour furrows accumulate silt and lose their effectiveness over a period of years, if a pasture or range is over-utilized. When this happens, new furrows should be constructed between the old ones. The old furrows will be supporting a denser stand of grass than the intervening areas. Any needed grasses or legumes should be sown in the new or reconstructed furrows as part of the maintenance. If the furrows were not constructed on the exact level, chunks of sod can be used to block the discharging points.

Photo by Soil Conservation Service

Figure 5.—A small type of contour furrow being constructed in a pasture by tool bar equipment. Vernon Adams farm, Sheridan County Soil Conservation District, Kansas.

In summation, on range and pasture land with runoff, contour furrows may significantly reduce runoff, erosion, and fertility losses. Moreover, they may increase soil moisture, forage yields and plant residues, spread water effectively, and provide some low cost water storage.

Storage is especially significant because floods in recent years throughout the Northern Great Plains states have caused a renewal of interest in water-detention possibilities on wide areas of grassland. Also the prevalence of drought in some localities, with its attendant shortage of forage, has stimulated interest in measure that will furnish additional pasturage. Research findings show the beneficial effects of contour furrows in reducing runoff and on vegetative response in the Northern Great Plains. The earlier objectionable features of the contour furrows have been largely eliminated by improvements in design, layout and construction.

LITERATURE CITED

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The Effects of Rainfall, Land Slope, and Cropping Practices on Runoff and Soil Losses

JOHN R. CARREKER

RAINFALL, RUNOFF AND SOIL loss data from studies at the Southern Piedmont Conservation Experiment Station, Watkinsville, Georgia, were made during the 1940-51 12-year period on cropland soils of the Cecil series as they typically occur on the sloping fields. Measurements were made on runoff plots on land slopes of three, seven and eleven per cent, with slope lengths of 105, 70 and 35 feet on these respective slopes.

The initial plan for these plots provided for a length of slope study on the three degrees of slope, using one cropping practice. The three lengths were 35, 70, and 105 feet. This plan was soon changed to a study of several cropping treatments on the three slopes, using the slope length nearest the recommended terrace spacing on each slope.

The slope lengths retained were principally the 105, 70, and 35 feet on the three, seven and 11 per cent slopes, respectively. All plots were 20.74 feet wide, giving areas of .05, .033 and .0167 acre.

The soil series was Cecil, a residual, deeply weathered member of the red and yellow soil group. Previous erosion had caused variations in depth and texture of the surface soil on the three slopes, so that the dominant depth of topsoils and surface textures were as follows:

Land slope percent	Topsoil depth inches	Surface soil texture
3	8	sandy loam
7	3 to 6	sandy loam to sandy clay loam
11	0	clay loam (essentially raw subsoil clay)

Earthen borders were used on the two sides and upper end of each plot. A sheet metal concentrating trough was across the lower end. Tanks, connected with divisor boxes, below the concentrating troughs held a representative portion of the washoff from each rain until it was measured. A plan of the plot and equipment layout is shown in Figure 1.

Rainfall was measured in raingages installed near each group of plots on the three slopes. A United States Weather Bureau standard raingage measured the quantity of rainfall, and a Fergusson-type weighing and recording gage provided data on time of occurrence, duration and intensity of the rainfall.

The plowing, planting, cultivating and other cultural practices were performed with standard farm equipment operated on the contour. The side borders of each plot were torn down ahead and rebuilt behind the passage of the several implements across the plots throughout the crop year.

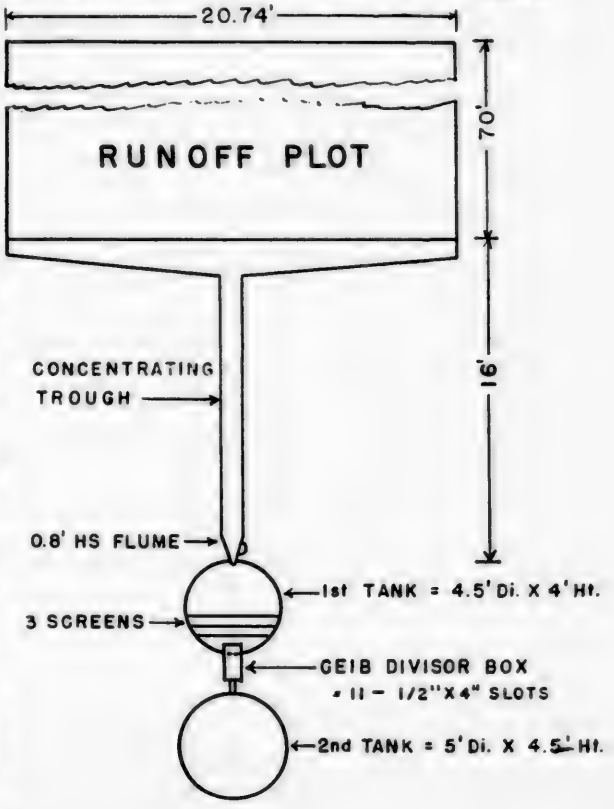
The six cropping practices studied contained a range in ground cover from none with cotton continuously to 100 per cent cover with sericea lespedeza, as shown in Table 3. Each crop-year in the rotations was under measurement during every year of record. The several crops were on single plots only on the three per cent slope, and on duplicate plots on the seven and eleven per cent slopes. The continuous cotton measurements were on triplicate plots on the 11 per cent slope.

Results from Runoff and Soil Loss Measurements

1. *Soil losses varied widely from year to year.*

The annual rainfall, runoff and soil losses on the continuous cotton check plots of seven per cent slope are

Figure 1. Runoff plot equipment at the Southern Piedmont Conservation Experiment Station, Watkinsville, Georgia.



John R. Carreker holds the position of agricultural engineer with the Southern Piedmont Conservation Experiment Station at Watkinsville, Georgia, in cooperation with the Agricultural Engineering Department, College Experiment Station of The University of Georgia Agricultural Experiment Stations.

given in Table 1. There was a range of almost 10 to 1 in erosion losses from year to year—51.34 tons per acre in 1943 to 5.33 tons per acre in 1950—during this 12-year period.

The runoff varied from 19.29 inches in 1948 to 6.77 inches in 1951, while the greatest and least amounts of rainfall were 64.66 and 40.47 inches in 1948 and 1950, respectively.

Erosion each year was influenced more by the number of erosive rains than by annual rainfall or annual runoff. The correlation coefficient between erosion and number of erosive rains was 0.95, which was highly significant at the one per cent level. The correlation between runoff and erosion was 0.63, this being significant only at the five per cent level. The relationships between annual rainfall to runoff and to erosion were 0.84 and 0.34, respectively. The rainfall-runoff relationship was highly significant, but the rainfall-erosion correlation was not significant.

Table 1. Annual rainfall, runoff and soil losses from continuous cotton on runoff plots of 7 per cent slope, 70 feet length, related to numbers of erosive storms.

Year	Rainfall	Runoff	Soil Loss	Erosive storms[1]	Soil loss from erosive storms	
	inches	inches	tons/acre	number	T/acre	Percent of annual erosion
1940	50.63	7.92	12.35	7	10.88	88.1
1941	41.99	8.67	18.81	7	17.06	90.3
1942	52.65	12.66	33.64	12	32.78	97.4
1943	54.75	16.06	51.34	15	50.48	98.3
1944	50.75	12.20	27.81	9	26.24	94.4
1945	51.42	8.75	17.57	5	17.08	97.2
1946	50.91	9.77	26.38	9	25.38	96.2
1947	56.13	10.67	11.71	5	8.82	75.3
1948	64.66	19.29	21.01	10	20.44	89.9
1949	49.34	9.23	7.91	4	5.66	71.6
1950	40.47	7.45	5.33	4	4.65	87.2
1951	42.54	6.77	11.83	5	10.52	89.9
12-yr. Av.	50.5	10.79	20.47	7.7	19.16	93.6

[1]An erosive storm was one that caused 1,000 lbs/acre or more soil loss from continuous cotton.

2. *Most of the erosion occurred in the spring and summer seasons.*

Rainfall and runoff were fairly well distributed throughout the year, as shown in Table 2. Soil losses, however, were concentrated in the spring and summer months. This was because most of the erosive rains occurred during those seasons. A few thunderstorms of high intensity and short duration caused most of the erosion damage on the land in cotton continuously.

Rains of large volume, long duration, but low intensity caused large amounts of surface runoff, but little erosion.

Conservation cropping practices, to be effective on sloping cultivated land, must protect the soil against the erosive force of high intensity rains. These rains occur most often in the spring and summer in this area. There is a far greater need for summer cover crops than for winter cover crops to control erosion on sloping land.

Figure 2. Planting and cultivating row crops are easier and yields higher in mellow soil where sod crops are turned into the soil ahead of the row crops.

Table 2. Seasonal rainfall, runoff and soil losses from continuous cotton on land of 7 per cent slope and 70 feet slope length, during the 1940-51 12-year period.

Season	Rainfall		Runoff		Soil Loss	
	inches	percent	inches	percent	ton/ac.	percent
Winter	14.28	28.3	2.90	26.9	3.48	17.0
Spring	13.78	27.3	2.39	22.1	5.39	26.3
Summer	12.90	25.5	3.16	29.3	10.17	49.7
Fall	9.54	18.9	2.34	21.7	1.43	7.0
Annual	50.50	100.0	10.79	100.0	20.47	100.0

3. *Soil losses were excessive from cotton grown continuously on terraced sloping land.*

The average annual rainfall, runoff and soil losses measured from the cotton grown continuously over the 1940-51 12-year period on three, seven and eleven per cent slopes were:

Table 3

Land slope	Slope length	Rainfall	Runoff	Soil loss
percent	feet	inches	inches	tons/acre
3	105	49.93	7.71	3.57
7	70	50.50	10.79	20.47
11	35	49.29	10.96	19.69

Soil losses greater than an annual average of 3.0 tons per acre are regarded as excessive. Accordingly, continuous row cropping, as with cotton, cannot be recommended on croplands in this area having as much as three per cent slope—and certainly not on steeper slopes.

Comparing the data from the three and seven per cent slopes, although the rainfall volumes were practically identical, runoff was somewhat higher and erosion greatly increased as the slope gradient increased, even though the slope length was shortened from 105 feet to 70 feet. This

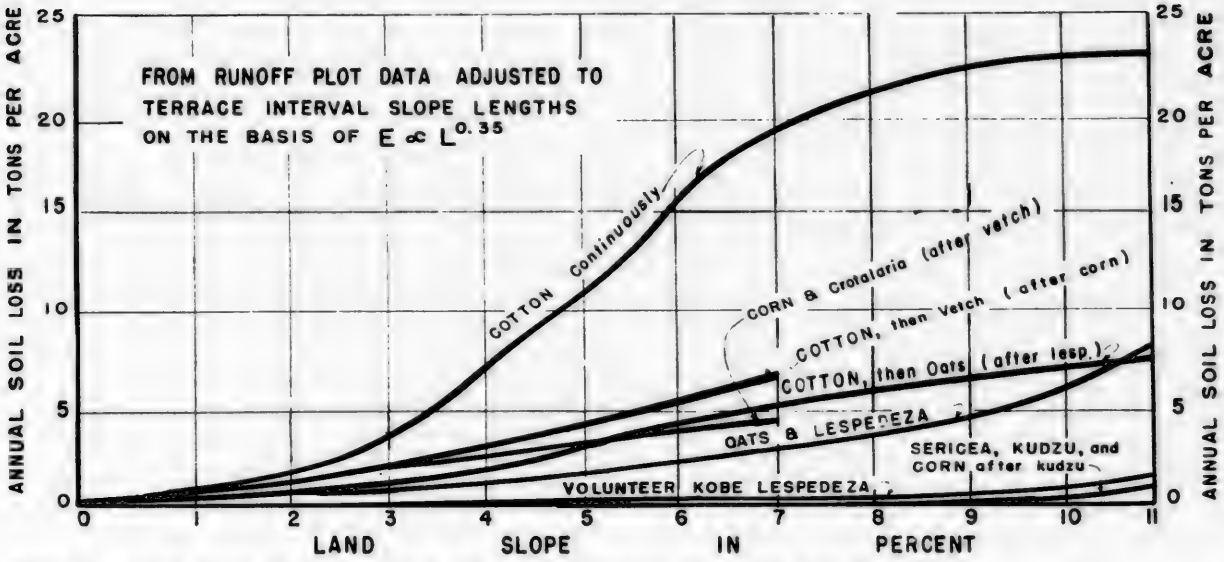

FROM RUNOFF PLOT DATA ADJUSTED TO
TERRACE INTERVAL SLOPE LENGTHS
ON THE BASIS OF E ∝ L^0.35
COTTON Continuously
CORN & Crotalaria (after vetch)
COTTON, then Vetch (after corn)
COTTON, then Oats (after lesp.)
OATS & LESPEDEZA
SERICEA, KUDZU, and
CORN after kudzu
VOLUNTEER KOBE LESPEDEZA
ANNUAL SOIL LOSS IN TONS PER ACRE
LAND SLOPE IN PERCENT

Figure 3. Average annual soil losses from selected cropping practices on terraced sloping land.

illustrates the importance of the degree of slope factor on soil erosion.

Comparing the data on the seven and 11 per cent slopes, we find that the data from runoff and soil losses are practically identical. As the slope was increased from seven per cent to eleven per cent, th e slope length was reduced by 50 per cent, from 70 feet to 35 feet. Soil losses were excessive on the steeper badly eroded land, even on shorter slope lengths than it is practical to provide by terracing. The change in soil texture, caused by past erosion on these fields, also probably affected to an undetermined extent the amount of erosion on these three slopes.

Musgrave[2] showed that erosion is affected by the soil, land slope, slope length, precipitation and cropping. The relationship of these factors is expressed by the formula $E = F S^{1.35} L^{0.35} P^{1.75} C$, where

E=average annual soil loss in tons per acre
F=soil factor
S=per cent slope
L=length of slope in feet
P=30-minute rainfall intensity
C=crop factor

[2]"The Quantitative Evaluation of Factors in Water Erosion—A First Approximation," by G. W. Musgrave, Journal of Soil and Water Conservation, Vol. 2, No. 3, July 1947.

[3]Terrace spacings are computed by the formulae:

$$\text{on slopes of 0 — 6 per cent: } VI = \frac{S+2}{2}$$

$$\text{above 6 per cent: } VI = \frac{S+6}{3}$$

where, VI = vertical interval and S = per cent slope.

The data in Table 3 were adjusted on the basis of this formula to the slope lengths of terrace spacings[3] in general use in the Southeast. By this means we arrived at the following computed soil losses applicable to terrace intervals on the three slopes:

Land slope percent	Slope length (terrace spacing) feet	Soil loss tons/acre
3	83.2	3.29
7	61.9	19.60
11	51.5	22.52

Soil losses ranging around 20 tons per acre per year can be expected to occur on the bulk of the rolling Southern Piedmont fields continuously row cropped to cotton on the contour, even though the fields are well terraced. Simple arithmetic $\left(\frac{1000 \text{ tons}}{20 \text{ tons}} = 50\right)$ indicates a probable life of 50 years until the soil is removed by erosion to plow depth. There is certainly little hope of securing badly needed soil improvement when the soil is eroding at any such rate.

4. *As slopes steepen, additional ground cover is needed for protection against excessive runoff and erosion losses.*

The six cropping practices tested on these runoff plots included a range in ground cover from none with continuous cotton to full year-around cover with sericea. The specific crops, together with the runoff and soil losses from them, are given in Table 4.

The runoff data from these plots are included in this table, because runoff is known to be but slightly affected by minor slope length changes.

These indicated soil losses are computed by adjusting the actual plot soil loss data to the recommended terrace interval slope lengths on the basis of the relationship $E = c^{c} L^{0.35}$.

The soil losses were affected much more than was the runoff by changes in the degree of slope. This was true with all cropping practices. But the most important point is that the amount of runoff was reduced and the soil losses were greatly lessened as the proportion of ground cover was increased on all the slopes.

Variations in crop growth on the three slopes contributed to these differences in runoff and erosion. Fertilizer applications and cultural treatments were uniform for a given crop on all slopes. The stands, growth and yields of the respective crops were generally best on the flatter land and poorest on the steep, thinner soil. Average seed cotton yields were 1046, 892 and 366 pounds per acre on the three, seven and eleven per cent slopes, respectively where cotton was grown continuously. The rotations increased the yields on all slopes.

The outstanding ability of heavy mulches to resist erosion on adverse slope conditions is shown by the very low soil losses from all three years of the rotation of oats and kudzu, kudzu and corn on the eleven per cent slope. Over two tons per acre of these plant residues were turned into the soil ahead of corn planting. This quantity of durable material in the soil helped greatly to protect the steep land from serious erosion in the rowcrop year. Also, the regrowth of kudzu vines after the last cultivation of corn covered the land by late summer, adding more protection.

The relationships of the soil losses and land slopes for the several practices listed in table 4 are shown in Figure 3. Data can be taken from these curves to estimate the annual soil losses from these and similar crops grown in rotations other than those listed in Table 2.

For example, assume a three year rotation on five per cent slope of (1) oats and sown annual lespedeza, (2) cotton, followed by vetch, and (3) corn after vetch green manure. The erosion from these crops would be 1.8, 2.9 and 3.3 tons per acre, or 2.7 tons per acre per year average for the rotation. Leaving the vetch out of this rotation would make erosion from corn similar to cotton after cotton. This would make the annual losses 1.8, 2.9 and 10.2 tons per acre, for an annual average of 5.0.

If the lespedeza was allowed to volunteer for a second year of growth, making a four-year rotation, the annual erosion losses would be 1.8, 0.1, 2.9 and 3.3, for an average per year of 2.0 tons per acre.

The data in Table 3 and Figure 3 suggest that cropping treatments should be adjusted to land class conditions. Summer row crops and winter degume combinations need to be confined primarily to the lesser slopes. Cropping practices on steeper slopes need sod crops in summer a part of the time. As the slope steepens, the proportion of sod crops to row crops should be increased.

The principle of adjusting cropping practices to the

Table 4. Runoff and soil losses from plots, adjusted[1] to terrace interval slope lengths on three, seven and 11 per cent slopes for six representative cropping practices.

Cropping Practice	Years of Record	Land slope in percent					
		3	7	11	3	7	11
		Runoff			Soil Loss		
		In.	In.	In.	T/ac.	T/ac.	T/ac.
Cotton continuously	1940-51	7.71	10.79	10.96	3.29	19.60	22.52
(1) Corn and crotalaria	1943-51	4.05	6.43		2.06	4.74	
(2) Cotton, then vetch	"	4.81	7.38		1.87	6.47	
2-yr. rotation average	"	4.43	6.90		1.96	5.61	
(1) Oats, then sown Kobe lesp.	1948-51	3.26	6.23		0.66	2.81	
(2) Cotton, then oats	"	1.69	4.21		0.59	5.06	
2-yr. rotation average	"	2.48	5.22		0.63	3.94	
(1) Oats, then sown Kobe lesp.	1941-51		7.07	9.64		2.90	7.96[2]
(2) Volunteer lespedeza	"		2.11	5.95		0.14	1.26[2]
(3) Cotton, then oats	"		5.23	6.87		4.85	7.48[2]
3-yr. rotation average	"		4.80	7.49		2.63	5.57[2]
(1) Oats and kudzu	1945-51			3.47			0.66
(2) Kudzu	1943-51			2.11			0.11
(3) Corn, then kudzu	1944-51			3.07			0.70
3-yr. rotation average				2.88			0.48
Sericea for hay	1945-51			3.54			0.70

[1]Adjusted from actual plot length measurements to the recommended terrace intervals slope length on the basis of $E = C^{c} L^{0.35}$, where E is erosion and L is length of slope.

[2]Years of record 1943-51.

land class conditions is basic to good conservation farming. Specialized practices like water conservation with farm ponds, drainage, irrigation, resetting forest land, planting perennial sods, terracing, etc. are all parts of an overall soil and water conservation program. In the final analysis, the crop rotation and crop management employed on the cultivated land of farms largely determines the success of the soil and water conservation program.

Summary

1. Soil losses varied widely from year to year. Erosion on land planted to cotton continuously ranged from 5.33 tons per acre in 1950 to 51.34 tons per acre in 1943. The range in water losses was not so great, being from 6.77 inches in 1951 to 19.29 inches in 1948. The number of erosive rains each year affected the amount of soil loss more than did the amount of either the rain or runoff.

2. Most of the erosion occurred in the spring and summer months, because most of the erosive rains came during that period.

3. Runoff losses were increased to a small extent, and erosion to a very great degree, by increased land slope even though the lengths of slopes for the seven and eleven per cent plots was only two-thirds and one-third the length of the three per cent plots. For example, the respective losses from cotton grown continuously on terraced slopes of three, seven and 11 per cent were 7.71, 10.79 and 10.96 inches runoff, and 3.29, 19.60 and 22.52 tons per acre soil loss.

4. Increased ground cover in conservation cropping practices reduced both the runoff and erosion. As the slopes steepened, more ground cover was needed to reduce the erosion losses to a satisfactory level. For example, average annual erosion losses from a 2-year rotation of corn and crotalaria followed by cotton and vetch were 1.96 and 5.61 tons per acre on the three and seven per cent slopes, respectively. Similarly, the average annual erosion from a 3-year rotation of oats and Kobe lespedeza, second year lespedeza, and cotton was 2.63 and 5.57 tons per acre on the seven and eleven per cent slopes, respectively. The average annual erosion was only 0.48 tons per acre from a three-year rotation of kudzu, kudzu and corn on the 11 per cent slope.

5. The principle of adjusting cropping practices to the land class conditions is basic to good conservation farming. The crop rotation and land management plan employed on cultivated land largely determines the success of the soil and water conservation program.

Multiple Use and the Soil Conservation Society of America

BERNARD FRANK

THE CONCEPT OF MULTIPLE use refers to the conscious management of each unit of land for its highest sustained productivity, both in its material and nonmaterial aspects. This concept has its roots in the clear-cut findings of scientific inquiry and common experience that soil, water, plant cover, and animal life are interdependent aspects of our natural environment. Out of these firmly grounded findings has come the strong conviction that satisfactory relations of soil, water, and the dependent living resources are essential to our survival, and that therefore all lands, in whatever location or form of ownership, should so be protected and utilized as to fully maintain these relationships.

This statement was presented by Bernard Frank at the Fourth American Forest Congress, held in Washington, D. C., October 30, 1953. Mr. Frank is a member of the Editorial Board of the JOURNAL OF SOIL AND WATER CONSERVATION. *He is in the Division of Forest Influences, U. S. Forest Service, Washington, D. C.*

It is precisely this indivisibility of land, water, and people that has led workers in the field of natural resource management to join together in forming the Soil Conservation Society of America, a professional association dedicated to promoting the science and art of constructive land use. The Society's direct concern in multiple use is reflected in its adoption of a national land policy on the principle that the economic, social, and cultural stability of our nation depends on the scientific management of natural resources in the public interest. Among other features, this policy visualizes as an ultimate goal in land use the application of a complete soil and water conservation program on every farm, ranch, forest, and watershed throughout the country. It looks to the efforts of individual landowners and organized local associations as the most effective means yet devised for meeting that goal. It also recognizes, however, that the sensitivity of the land to abuse, and the tangible

(*Continued on page* 137)

Water Rights and Our Expanding Economy

C. E. BUSBY

The existing common laws and administrative systems of many of our states constitute limitations upon orderly development, wise use, and conservation of water essential to our expanding economy. There is need for changes in these systems through greater recognition of the public interest. This is the second part in a series of three articles.

IN THE WEST, an entirely different system of water rights and administration for streams has developed over the years, beginning with the early Indian, Spanish and Mexican irrigation customs, such as the community acequias that are still in operation in New Mexico and recognized in the laws of that state. But the main part of this system of prior appropriation was given to us by the early miners of California, where hydraulic gold mining required enormous quantities of water sometimes at points far removed from claims which touched the streams. It should be recalled that the riparian system does not permit use on lands which do not touch the streams and is limited largely to natural water uses.

Gold was discovered in California in 1848. Miners came from over the world, seeking their fortunes. They brought with them their mining customs. With rapid development, disputes arose over water essential to wash the gold bearing gravels. There was no system of American law in effect. Bloodshed resulted. In order to reduce bloodshed and facilitate mining operations, the miners fell back upon their mining customs as the only rules of guidance known to them for the settlement of disputes, excepting, of course, for the six-shooter. These customs operated something like this:

He who first discovered the gold, developed his claim within a reasonable period of time, and continued his development diligently, could have the benefits of his expenditure of funds and labor. If he failed to develop his claim and keep working it diligently, his right to mine the gold was forfeited.

The miners carried this concept over into the field of water in this way. They established the rule that he who first diverted water from a stream, placed it to beneficial use within a reasonable period of time, and continued to so use it, should be entitled to the benefits of his expenditure of funds and labor. But if he wasted it or failed to use the water beneficially, and continued this when others were in need of water, he would lose his rights. This placed a great deal of emphasis upon the beneficial use and conservation of water resources, and the prevention of waste in contrast to the riparian system which laid little or no stress on these matters.

C. E. Busby is a member of the immediate staff of the Director of Planning, Soil Conservation Service. He is serving as consultant to several state committees and commissions working on water legislation. *The third and final section of this paper will appear in the July issue of the* JOURNAL.

Furthermore, the appropriative right related to a specific quantity of water at a given time and place. It was an exclusive right of use rather than a use in common, as under the riparian system. It was limited by the corresponding rights of prior locators or appropriators and, from the standpoint of reasonable beneficial use, by those of junior appropriators whose rights were later in time. When the stream had any water sufficient to reach the land of an appropriator, at the time he was entitled to use it, he was fully protected in his exclusive right.

This may seem a harsh policy to some. But how can one operate an irrigated farm, industrial plant, or municipal water supply system unless he is assured of a specific amount of water at a given time and place? This is one of the factors involved in this question of security of investments or, shall we say, dependability that the water supply can be used when it is needed and available. And how are water resources going to be developed and used wisely, unless there be some reasonable incentive of this type for private enterprise to invest its capital? To this extent, then, the system of prior appropriation does provide more security than the riparian system.

In 1850, when California was admitted to the Union, the legislature adopted the English common law as rule of decision and by so doing adopted the riparian law for streams then incorporated into the common law. In 1872, the legislature adopted the customs of the miners as local rule of law. Congress had adopted these customs as rule of law on the public domain in 1866 and then amended it in 1870. The California courts began to recognize both of these rules in connection with disputes not affecting the government title of state or federal lands.

In the 1880's, the dual system came in for exhaustive consideration by the courts of California and the rigid limitations of the riparian system were upheld. Forty years later, the rule was again upheld. This case is worth special comment. One who owned meadow lands far down the San Joaquin Valley claimed he was entitled to have the stream come down to him and spread out so as to wet his meadow lands in time of high flood flows; and that any water development in the stream above him which might in any way interfere with this natural flood right should be enjoined by the courts. Water development in that stream system was impeded by this rigid ruling. As a result, the people of the state turned to constitutional amendment to pare down the rigid limi-

Figure 1. Water requirements for agricultural, industrial, urban and recreational needs are growing—hence the need for a basic water policy.

tations of the riparian system and open the way for greater development and use of water resources.

In Oregon, the courts held that the application of such a rigid rule would be going too far. Thereafter, the Oregon courts and legislature progressively limited the riparian system to the point where it no longer appears to be as important as before.

In Kansas, this problem persisted as late as 1945. A special committee was appointed by the governor in 1944 to prepare recommendations to meet development and conservation needs in that state. The statute which was recommended and adopted in 1945 was subsequently upheld by the courts. As a result, the riparian system had to take a less prominent place in the affairs of Kansas.

These and other experiences in the western states point to the fact that, in those states where the riparian system had previously been adopted, the western system of prior appropriation for streams has been gaining in favor as a more practical device for meeting water needs, especially for artificial purposes and at points removed from the stream banks. On the other hand, the riparian system has been losing in favor though it is still important in California. Of course, the eight intermountain states never did accept the riparian system.

In contrast to this situation, the eastern states all continue to maintain the riparian system, though it does not appear to have been tested or spelled out by the courts nearly as far as in California. In the East, there is only limited use of the appropriation concept. This seems to have arisen out of statutes authorizing mill dams and the application of common law principles to controversies over mill rights.

So much for some questions of broad policy applicable to well-defined streams. We can now turn our attention to diffused surface waters which are of direct concern to farmers in Soil Conservation Districts.

Rights to Diffused Surface Waters

You will recall that surface waters which have not found their way into well-defined stream channels are classed in law as diffused surface waters. The first system of American law dealing with these waters, except for Louisiana, is said to have originated in Massachusetts. It is called the common enemy doctrine. As later developed, this system holds that he who owns a piece of land is entitled to treat his diffused surface waters as a common enemy and to fight them off about as he pleases. He may throw the waters up against a neighbor, down against a neighbor, retain them, store them, use them, and and in fact do almost anything he wishes with them, just so long as he does not unduly collect, concentrate and discharge them upon his neighbor in unnatural or unusual quantities. In other words, by reason of his land ownership, he has nearly full dominion and control over his own diffused surface waters. However, the extent of rights to use the water does not appear to have been fully determined.

This system does not seem to recognize the natural watershed conditions controlling the movement of waters. Many states, such as Virginia and South Carolina, adopted this system in their early history. Later, some of our states, such as Mississippi, broke away from this concept to that of the Code Napoleon, again through the influence of Chancellor Kent. They adopted thereby what is called the civil law rule.

This rule holds that the upper landowner, by reason of his ownership of land, is entitled to have his diffused surface waters come down to and pass over the lower lands of his neighbor without undue interruption. In other words, the upper landowner has an easement over his neighbor's land for the passage of these waters. But here again he must not unduly collect, concentrate, and discharge his diffused surface waters upon his lower-lying neighbor in unnatural quantities. This system seems to have recognized the natural drainage characteristics of watersheds and tends to prevent obstruction of runoff, but doesn't say much about the extent of use rights. It is more in the nature of a drainage policy.

It can be seen that both of these systems employ the familiar reasonable use rule regarding artificial collection, concentration, and discharge of waters. It is said that some states now place more emphasis upon this aspect than any other. In due course, this may become a dominant rule with respect to the damage aspects of diffused surface waters.

Which of these two rules of law is the better is not apparent at present, for there are so many different topographic, drainage and land use conditions to consider. Fo rexample, coastal areas in Florida, South Carolina, and Georgia constitute one type with their own special problems. Another type is the more steeply sloping topography of the Piedmont section. Still another type is the mountainous topography of Virginia, New York, or New England. This might be a field of law calling for considerable special study, especially as the work in soil conservation districts moves forward and greater use of these waters is made for irrigation and farm recreation purposes. But we must now turn our attention to ground waters.

Rights to Waters in the Ground

The law of each state with respect to ground waters in well defined subterranean streams follows the same rules as those in effect for surface streams. So we need not dwell on this phase of the subject. What remains is the law for percolating ground waters.

The law of percolating ground waters seems to have a different origin and development in most states. Much of our early common law on the subject seems to have come from England, where it is said to have developed under the influence of Lord Coke. His concept was based on the theory that he who owned the land is entitled to the air above to the uppermost reaches of the heavens and the soil and other resources in the ground down to the center of the earth. It is the rule in states like Virginia. But even this rule does not appear to have been adopted as yet in South Carolina.

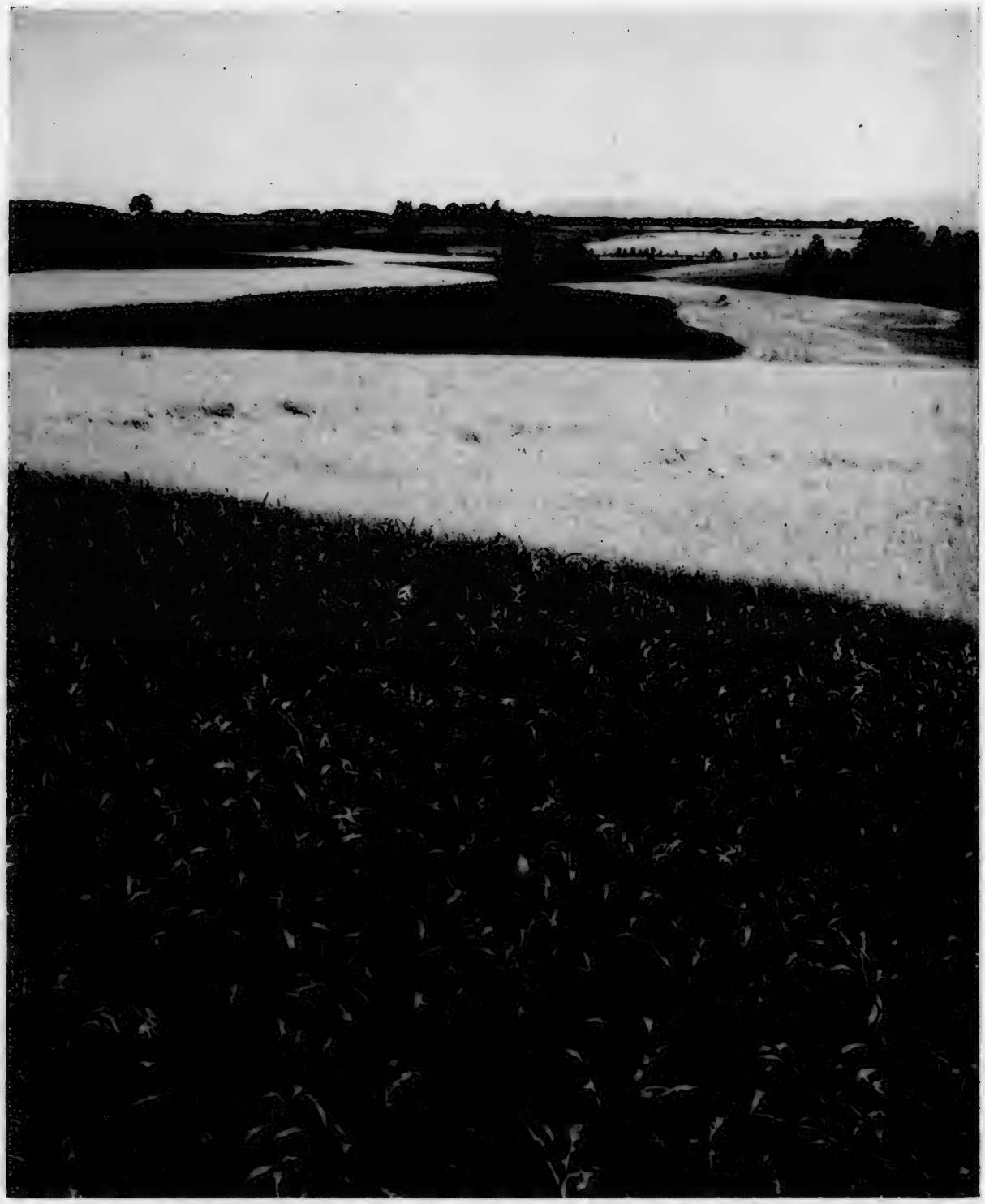
There is one aspect of this concept which needs careful consideration. Whereas the riparian and appropriation concepts both recognize the moving character of water in streams, the concept of Coke does not recognize the moving character of ground water or of oil and gas. Under the riparian or appropriation concepts, one does not own the water while it is moving in the stream. He has only a right to the use of the water as it comes down to him. Under the Coke concept, it is held in law that the land owner owns the ground water, even though it may be here today and gone tomorrow or next week or next month. Ground water moves from higher to lower points just as surface water moves, albeit slowly. Let's see what this situation leads to in terms of practical water development and use problems.

The strict rule of the English common law for ground waters holds that he who owns the land is entitled to develop his ground water as he pleases, no matter what effect this may have upon his neighbor's ground water supply. In other words, one landowner may expend several hundred or even several thousand dollars in developing ground water for use, yet his neighbor may put down a well to greater depth or pump his well at a more rapid rate and thereby completely cut off or destroy the first landowner's water supply for all practical purposes. And the latter can do nothing about it. Does this concept offer any encouragement or security for investment of funds in ground water development? Does it emphasize wise use, conservation and the prevention of waste? Is there any administrative guidance which attempts to bring about development and use in accordance with capabilities of the ground water reservoir and the land? It would seem that the answer to each of these questions is in the negative.

Because of this situation, several of our states have broken away from this strict, harsh rule. The first was New Hampshire, in 1862. The courts of that state have adopted what is called the rule of reasonable use. This holds that one may develop and use his percolating ground water about as he pleases, just so long as he does not maliciously, needlessly, or carelessly, or by exporting water supply. This tends to provide some security for investments and some prevention of waste, but not very much.

The treatment of water courses to minimize the damage of sedimentation and floods as an important and necessary practice. This "before" picture, taken on Buffalo Creek in Erie County, New York, showing streambank erosion and gravel bars is typical of many streams.

Corrective measures are shown on the same stream a few months later. The banks have been sloped and rip-rap has been placed. This is a phase of the Buffalo Creek Watershed development program which is now well underway.



Contour strip cropping is an important erosion control and water conservation practice. This 328-acre farm near Hydraulic, Virginia, has been in contour cultivation since 1937 when it was established.

All roads lead to Jacksonville, Florida—the scene of the 1954 annual meeting of the Soil Conservation Society of America. Members, while enroute, will see slopes along highways completely stabilized. This is a scene near West Soperton, Georgia.

In the west, some of the states have adopted the appropriation concept for percolating ground waters. A few of these states place administration of development and use at the state level. There is also administration at the local level, but this pertains mainly to control measures. The latter would seem to be practical in view of the wide local variation in soil and bedrock conditions which limit the occurence and yield of ground water. Of course, this appropriation system places emphasis upon beneficial use and conservation, security for investments, and responsibility for administrative guidance. Administration along these lines is not a simple task, as the experience so far would seem to indicate.

One can see from the foregoing that the policy of the water law for streams has evolved from one of nonuse and monopoly, insecurity for investments, and lack of administrative responsibility, in the case of the Code Napoleon, to a policy of maximum beneficial use and conservation, security for investments, and administrative responsibility under the prior appropriation system.

In the case of ground waters, the policy of the law has evolved from one of waste, insecurity for investment, and lack of administrative responsibility toward maximum beneficial use and conservation, security of investment, and local or state responsibility for guidance in development and use.

This does not mean that the common law systems are entirely impractical or that they do not have their good aspects. But it would appear that experience points to the prior appropriation system and the correlative rights doctrine as the more useful and practical in meeting situations of shortage, needs for artificial uses of water, and the needs of an expanding modern economy with its tremendous emphasis upon water in given amounts at the right time and place.

Changes Needed in Existing Systems

Keeping in mind the weaknesses of the common-law systems and the stronger points of the system of prior appropriation, the question arises, how should state leaders approach consideration of needed improvements in such states as South Carolina, Virginia, Mississippi and Kentucky, where the common-law systems prevail in whole or in part? Perhaps a brief review of the experience of other states might be helpful in answering this question.

If permanent and lasting changes are to prevail, the people of each state should come to understand the principles of water law and administration. They should have full opportunity to make their own decisions as to what should be done and how to go about the job once they do understand. After all, this is their problem. Their leaders should give all organization representatives a chance to express their views and desires.

Thus, it would seem that the development of understanding and acceptance of sound principles of water law and administration, and of confidence in better ways of doing things, is of utmost importance. It would not seem wise for leaders to try to take too much at one time, or to attempt the highly controversial phases at an early stage and run the risk of setting back any such undertaking for several years.

What then are the things to be avoided? What steps can be taken early with reasonable prospects of successful enactment of legislation? There are no hard and fast answers to these questions, but there is considerable experience to draw on which may be helpful in pointing the way.

Establishment of Basic Water Policies

It is evident from experience in several states that people can readily understand and come to accept with confidence certain principles that are essential to a sound water policy for any given state. These may be divided into principles concerning (1) the essentiality of water to all economic activities in the state; (2) the changes in demand for and use of water require that water be put to maximum beneficial use; (3) the right combination of land-and water-use adjustments and the construction of complementing works of improvements to assure effective water development and management, thereby making practicable the wise use and conservation of surface and ground waters as well as land; and (4) the waste and unreasonable use or methods of diversion and application of water are against the public interest. The other basic aspect is the matter of the state assuming full responsibility for the use and management of its water resources within its territorial limits, working through statewide and local agencies for control of development, use, and management.

Another consideration in this policy phase is to secure the appointment and financing of a water resources commission to work out the details of how best to implement such a policy in the fields of surface waters, ground waters, and organizations, including both the use and damage aspects. Such a commission affords an opportunity for study by members of the two houses of the legislature, together with other key leaders over the state, as a basis for facilitating consideration of the entire problem by the legislature as a whole and by all the people of the state. Appointees to such a commission should be of the highest caliber. Their objective might be the welfare of all the people of the state.

One point of caution: This work is too important to

the people of any state ever to let it become involved in partisan politics, or to become the tool of any special interest, or to become the plaything of any individual seeking personal advantage and glorification. There is plenty for all to do and real credit, too, if leaders will see to it that selfish motives have no part in the undertaking.

Implementation of Water Policies

The succeeding steps for implementation are more complex. They involve the determination as to the extent to which the three branches of state government, as well as local units of government, will assume responsibilities for water development, use, and management. Furthermore, some of these steps are much more controversial than others. Thus, the timing of each succeeding step is extremely important. Perhaps a review of experience in these matters would be helpful too.

The matter of control of damage is very controversial, especially concerning such phases as stream pollution. Most states have some sort of legislation in this field. If consideration of this step were taken second, it might involve the risk of incurring so much opposition as to set back the entire undertaking for several years. It might, therefore, be put off for the time being. Furthermore, the existing laws may be adequate for the present.

Similarly, group organizations for water supply and disposal are also controversial. They involve the sensitive question of financing by assessment, taxation, issuance and sale of bonds or otherwise. These organizations may be essential, however, if water supply and disposal works are to be operated and maintained as well as constructed. But consideration of organizations might be put off temporarily because of this controversial aspect.

As for ground water control, nearly everyone will agree that something should be done about wells which flow open, and waste water or dissipate artesian pressures. Nearly everyone will agree that something should be done about the control of water tables when their lowering may have adverse effects locally. But when it comes to final determinations in the legislature, how many of these same people will say, "That's fine, but don't come out on my land and tell me what to do about my well!"

This attitude is understandable when we stop to think that our existing common-law system has established a tradition of considering ground water as a part of the soil rather than a moving resource with very great community of interest. It would seem that a well conceived and intensive program of education is required in this field before real progress can be made. Thus, unless ground water problems having legal implications are especially acute, they might be put aside for a year or two. But they should be taken up just as soon as it is practical to make progress in this field. The control of development and use of ground water is extremely important. It cannot be separated from surface water development and use.

This brings us back to surface waters. We have said that the law of diffused surface waters needs special study. So, legislation for streams might well be considered as the implementing second step, after a basic water policy has been formulated and adopted. There is real need for legislation in this field—farmers, towns and cities, and industries are all dependent upon this relatively dependable source of supply.

People can see streams. They can understand stream behavior better than they can understand the behavior of ground water. It is something on which progress can be made toward establishing sound legislation. *Furthermore, the state must assume a larger measure of responsibility for streams because they usually are not confined to county boundaries and some even cut across state and international boundary lines.* Most eastern states have not placed broad responsibilities in the executive branch for the administration of rights and development for streams. They have left past of the job to the courts or have made no provision whatever.

It is extremely important for the state to maintain a small executive unit with competent personnel to determine the available water supplies in each drainage basin, the portion of a given supply needed to satisfy all existing water rights in that basin, and the portion which is available for appropriation to meet changing needs. Such an agency could also serve as a clearing house for water facts, working cooperatively with all other state agencies concerned and with appropriate federal agencies, such as the United States Geological Survey and the Soil Conservation Service. Such an agency can also provide staff assistance to the governor in helping to guide private groups, local governments, and other state agencies in developing plans and programs for water use and management. Thus, this step is basic to all succeeding steps, even though much of the total job in this field has to be done eventually by local organizations.

If these initial steps can be taken successfully, it may then be possible through effective administration to build confidence in improved ways of doing things. This confidence then affords a good foundation for making progress on some of the more controversial water problems previously mentioned.

Wanted: Factual Data for Evaluating the Effect of Water Conservation Programs on the Land

LLOYD L. HARROLD

Industries, cities, and other groups, large and small over much of the nation have recently gone through a period of water shortage. In many areas, the water-deficiency period is not yet over. Regardless of the fact some winter and spring rains have somewhat recharged water reservoirs, it is paramount that plans be developed now to meet future dry periods when water demand is likely to be even greater.

MANY INDUSTRIES, CITIES, and other groups over the country are coming face to face with the fact that their limited water supplies will not allow for further expansion. Industries will not move into a city where the water supply is inadequate. To meet the need, water resources—both surface and underground—must be developed and conserved to the utmost.

Watershed management programs have not, until recent years, been given any consideration in such developments. The plan has been to construct surface reservoirs for temporary storage of runoff water. In many cases, much of this storage capacity has been lost from siltation of soil eroded from the agricultural headwater lands. Industries, cities, and many other groups are now desiring action programs on entire watersheds to safeguard and improve their water supplies. They are looking upstream to the headwaters for land-treatment and water-retention works that will be conducive to the yield of clear, usable water downstream as well as to improvement in the recharge to ground-water supplies.

To the downstream water user, *water is a crop of the drainage-area lands*. Nearly all these lands, however, are used for the production of other crops such as forage, timber, and cultivated plants of great variety—all of which use water in their production process. Once the vegetative plants use water, the quantity thus used can not ordinarily be considered as being available for downstream use. It is apparent that in some areas, conflict may arise over the upstream and downstream demands for water. Paramount therefore, in watershed planning is an early evaluation of the influence of plant cover and land use on water yield.

The multiplicity of water uses on a drainage basin along with the complexities of the land-surface cover and treatment, geologic influences on ground-water movement, and the like, make watershed-improvement planning one of the most challenging of all resource-management tasks. I would like to tell you that we know *all* the facts and are *now* ready to plan and put into action certain land practices that would produce a calculable wateryield change downstream. This, I can not do. Those who are engaged in land-use and hydrologic watershed studies know that this goal is far from achievement for the country as a whole. Ohio may be one of the leading states as far as *its* inventory of water data is concerned. Yet its "stock pile" of data for meeting the water-conservation planning needs is distressingly inadequate.

The watershed-management approach to the water problem is becoming readily accepted over the country. Experts are being retained by local groups to make recommendations for action programs to alleviate water shortages. This is good progress. Yet, perhaps one of the most important items for everyone to consider is the fact that research and "fact-finding" in this field needs a great deal more private and public support. More facts will provide for better plans and with more ecomomy.

Actually, at the present time the extent of active, productive watershed and land-use hydrologic studies is much less than that 10 to 15 years ago.

It is obvious that with the present and future trend for more watershed programming, the present trend in research for the development of adequate factual data should be correspondingly increasing. It is to be realized, however, that all watershed planning can not be delayed until such research is completed. Hydrologic data now available, however inadequate, can be analyzed and used as a basis for immediate watershed planning. *In the present state of knowledge on the subject "effect of plant cover and land use on water conservation," one can reasonably state that watershed planning for water conservation is an "art" rather than a "science."*

It is not generally possible to take the research results from a one-acre experiment, and by multiplying them by 10,000 evaluate the hydrologic effect for land-use changes on a 10,000-acre watershed, that is, with any mathematical certainty. There is a definite need in this field for development of basic data and of techniques for applying small-area results to larger areas.

For the present, let us consider some of the observations

Lloyd L. Harrold is a member of the Soil Conservation Society of America and project supervisor of the Soil and Water Conservation Research Station, Agricultural Research Service, United States Department of Agriculture with headquarters in Coshocton, Ohio.

on small-area research projects where the effects of land use on water conservation has been studied for several years. Data from the Hydrologic Research Station[1] near Coshocton, Ohio will be used to illustrate such effects.

Water intake rates into the soil have been found to vary greatly throughout a storm—usually starting with high rates at the beginning of the storm and diminishing to low rates as the soil pores filled. These intake rates differ materially according to the soil type. Vegetative cover has had a significant effect on water intake rates on many different soils. In Table 1 are given data on water intake for two different soils, and for different plant cover.

Water intake into the soil where plants almost completely covered the land surface amounted to about 20 inches for a growing season. For areas of only partial land coverage, such as row-crop cornland, water intake totaled 14.35 to 16.25 inches. Full plant cover was effective in providing four to six inches more water intake than the corn land. For the well-drained soil, there appears to be practically no difference between the amount of the May to September water intake of wheat, meadow or woodland—as long as the soil surface is protected from the beating action of rain drops. Over-grazing of grassland or pasturing woodland would noticeably affect this relationship. Protection of the soil surface of cornland by a mulch has been observed to reduce surface runoff by more than 1.5 inches during the May-September period.

The ultimate effect of plant cover on water intake has not yet been attained. We who are close to field tests related to this subject feel that there is still much room for improvement.

It is evident that plant cover has some measurable effect on water intake. The next questions to be raised are "*What becomes of the intake water?*" and "*How much effect has plant cover on recharge to ground water?*" Actual field data to supply answers to these questions are few and far between. However, let us now reason together on this subject.

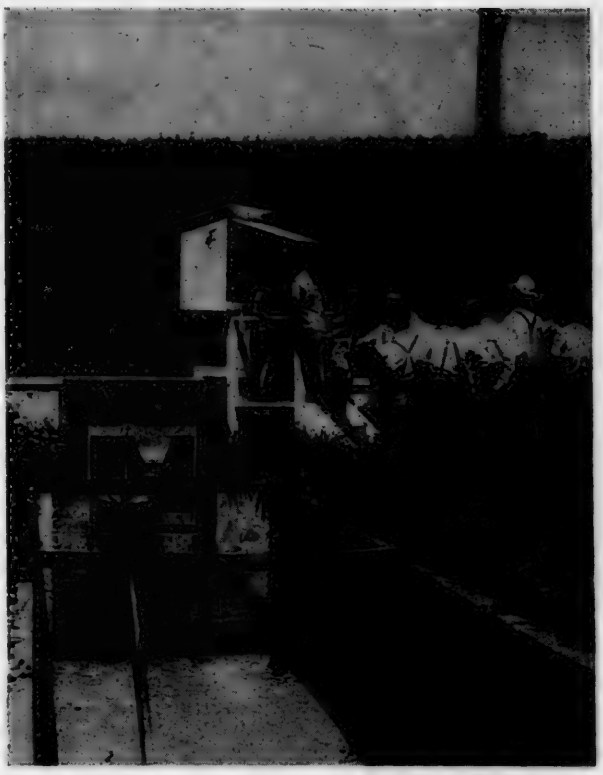


Figure 1. The amount and rate of runoff for different crops is carefully measured.

First, it is necessary at this point to consider a few fundamental items of soil physics. Soil consists of solid, liquid, and air. The space between the solid particles is made up of pores of many different sizes. To evaluate soil-water relationships, the pore sizes are divided into two ranges—(1) capillary pores which are small enough

[1]Maintained by Agricultural Research Service, United States Department of Agriculture, in cooperation with the Ohio Agricultural Experiment Station.

Table 1. Effect of plant cover and soil permeability on surface runoff and water intake, 1950.

Plant cover	Watershed No.	Slope	Watershed[1] treatment	Soil permeability	Surface runoff		Water intake[2]
					May-Sept.	Year	May-Sept.
		percent			Inches	Inches	Inches
Corn[3]	103	11	Contour	Slow	4.31	6.33	16.25
	110	13	Straight row	Slow	6.21	7.73	14.35
	128	14	Contour + mulch	Slow	4.18	—	15.70
Wheat[3] to meadow	109	13	Manure mulch	Well drained	.57	.62	19.99
	123	6	Manure mulch	Slow	1.27	5.15	18.69
Meadow	130	22	—	Well drained	1.02	1.59	19.75
Woods	131	22	—	Well drained	.18	.28	20.59

[1]Small watersheds, less than three acres in size.
[2]Actual rainfall on the different watersheds was used in these calculations. Intake = Rainfall minus runoff.
[3]Rotation cropland, four years corn, wheat, meadow, meadow.

Figure 2. All the rainfall, including the amount and intensity is measured.

to hold water against the downward pull of gravity, and (2) large or aeration pores which are readily drained of water soon after heavy rainfall. It is through the large pores that water drains fairly rapidly to the lower depths of the root zone. If the quantity of intake water is great, there may be enough to fill the capillary pores to a significant depth and still leave some water to drain to the water table. The amount of water held in the soil against the pull of gravity is called "*field capacity.*" The amount of water in the soil when all the pores are filled with water is termed "saturation."

Capillary moisture in the plants' root zone is depleted by crop use (transpiration) and by direct evaporation into the atmosphere. The season of most rapid soil-moisture depletion in Ohio is May-September. Moisture in the upper sections of the plant root zone (to a one- to two-foot depth) is depleted much more rapidly than in the lower sections. Much of the intake water during this season normally disperses into the capillary pores of the upper root zone. Except for unusually wet periods in the growing season, very little water in that period reaches ground-water tables that lie more than a few feet below the surface.

Let us again consider for the moment the observation mentioned before—that grassland increased the water intake over that of cornland by four to six inches in the growing season. Then from our concept of the soil and its moisture fluctuations with plant influences, let us continue our reasoning process in tracing the likely disposal of this additional soil water. First of all, the question arises *"With more soil misture available, will the plants use up much of this additional moisture?"* Evapotranspiration records from the unirrigated lysimeters at Coshocton show practically no difference between the annual water use by rotation corn and grassland. It may be possible, then, that some of this additional water intake grassland would directly, or indirectly, add to ground-water recharge.

The effect would be direct if the additional moisture came at a time when much of the soil profile above the water table was about at field capacity. The effect would be indirect if the additional intake water was merely absorbed by the capillary pores thereby raising the moisture content of the profile nearer to field capacity and consequently advancing the time when it would reach field capacity and drain water to the water table. The evaluation of changes in ground-water recharge resulting from differences in plant cover or tillage is, for the most part, conjectural. More field observations will greatly aid this evaluation.

Short-term lysimeter observation show that percolation into the shale rock at the eight-foot depth—a measure of ground-water recharge—was about ten inches per year for grassland and five inches per year under cornland. The four-year rotation plan of land surface usage was corn, wheat, and meadow. The 2-year meadow was comprised of timothy, red clover, and alfalfa. Annual precipitation during the grassland years averaged 36.13 inches and that for cornland years 35.35 inches.

A good plant cover thus had the effect of increasing ground-water recharge. We must also realize that a good plant cover could, in some cases, decrease recharge as percolation from permanent deep-rooted grass and legumes has been observed to be about six inches per year less than that from good bluegrass. In this case, the records show that the plants with deep roots used, by evapotranspiration, more soil water, thereby diminishing the supply for percolation to ground water.

Records of stream flow can, in some instances, be used to evaluate changes in ground-water storage caused by plant-cover differences. Where nearly all of the flow of a stream is supplied from ground-water sources, increases or decreases in ground-water storage usually result in

similar changes in stream flow. At the Coshocton Station, there is a 43-acre watershed, two-thirds of which was reforested in 1938, the other third being in mature hardwoods. The flow in the stream at the outlet of this watershed is derived mostly from ground-water sources. Prior to reforestation, the land was covered with shallow-rooted poverty grass and brush. Records showed that surface flow from either the grass or wooded area was less than one inch per year. Since the new trees have become established, the surface runoff is still less than one inch per year.

Stream-flow records tell a different story. Since 1944, six years after tree planting, flow in the stream appears to have averaged about two inches per year less than it was before. It is possible that the planted trees had developed a deep root system and extracted more soil water by plant transpiration since 1944 than the shallow-rooted grass and brush, prior to reforestation. It is significant to note that large (10 and 25-year frequency) flood peaks from this 43-acre watershed have been about 20 per cent less after the planted trees had established a ground cover, than before. The reduction of the 2- and 5-year frequency floods has been in the order of 30 to 35 per cent.

It is to be realized that the foregoing relationships have been derived from only a few years data. It is possible that results of a longer study might change the values considerably. We must also appreciate the fact that differences in soils, geology, climate, physiography, and other factors can, to various degrees, modify these same relationships. Additional research and analysis are expected to provide a means for modifying localized findings for wide spread application.

Figure 3. This instrument measures the amount of rainfall that percolates to the ground water reservoir.

Summary

1. To realize that plant cover and land use have an effect on water intake and ground-water recharge is an important beginning. Much progress in this direction has been made over the country in the past decade or so.
2. For planning water-conservation and watershed action programs, it is not enough just to appreciate the fact that there is an effect. Economic factors demand that we be able to evaluate the effect of watershed-management programs on water yield at various places from the point the rain drop falls to its final resting place in the lake or ocean. A great deal more research and analysis are needed before this can be accomplished with the desired degree of accuracy. Actually, there is at the present time, only about half the publicly-supported, active, productive, watershed hydrologic research in the United States, compared to that of ten to 15 years ago. This condition should not be.
3. Hydrologic research work on watersheds near Coshocton, Ohio reveal that changes in plant cover and land use do have an effect on water intake which, in turn, may influence ground-water recharge to some degree.
   a. Plant types that provided complete soil-surface coverage were found to be effective in increasing water intake by about four to six inches per year over that of row crops such as rotation corn.
   b. It is possible that some of this additional intake water may, either directly or indirectly, increase ground-water recharge. Records from cropland lysimeters showed that annual percolation at the eight-foot depth from grassland —a measure of ground-water recharge—was five inches greater than that from cornland.
   c. Reforestation of a shallow rooted grass and brushland watershed resulted in two inches less stream flow per year. Flood peaks for ten to 25-year frequency were reduced 20 per cent and those for 2- to 5-year frequency reduced 30 to 35 per cent.
4. It is important to realize that results and relationships developed from short-term records may be modified materially as longer records become available.
5. Methods must be developed for adjusting localized findings for widespread application.

Some Physical Facts About Connecticut Soils

C. L. W. SWANSON

For a long time soil scientists have looked at the soil from a chemical point of view. Perhaps this is understandable. Chemically some of our soils are loaded with fertilizer nutrients but physically they are at a low ebb. Farmers began to report that additional fertilizers did not do any good. Soil scientists tried chemical means of research and found that this did not answer the problem. Then some soil physicists began some probings. Many times it was quite easy to show that improved structure would increase production. With this small beginning interest has grown until now in the northeast the principal cooperative research of the Northeastern Soil Research Committee is one dealing with soil structure. Conservation and good soil structure go hand in hand. With increased knowledge from research on how to improve structure we can expect better conservation of our soils.

SOIL CONSISTS of finely ground rock material, organic matter, soil air and soil water. The composition of a silt loam, for example, is about 45 per cent mineral matter, 5 per cent organic matter, 20 per cent air, and 30 per cent water. On a volume basis, such a soil has about 50 per cent solids (mineral and organic matter) and 50 per cent pore space (soil air and water content). These proportions represent optimum conditions for plant growth for a soil of this texture.

About 95 per cent of the solids consist of mineral matter and 5 per cent organic matter. The physical properties of soil depend mainly on this mineral part. It forms the skeleton of the soil.

These mineral particles grade in size from gravel and rocks to those which are not visible even with a microscope. Sand, silt and clay are the most important of these separates. It is the proportion of these various sized separates in a soil that determines its texture. Soils high in sand are sandy textured, those high in silt have a loamy texture, and those high in clay a clayey texture. Thus we use such terms as fine sand, sandy loam, silt, silt loam, silty clay, clay, etc.

Texture is a natural characteristic of soil, i.e. one cannot change a fine sandy loam to a clay loam by some cultural treatment such as by adding fertilizers or by tillage methods.

Soil Structure Different Than Soil Texture

Another important physical characteristic of soil is its structure. The term structure means the arrangement or grouping of the soil particles into aggregates.

Under virgin conditions, soils do form kinds of structure characteristic to the local environment. It differs from texture in that it can be changed or altered. Whereas texture is concerned only with the amounts of sand, silt and clay in a soil, structure is concerned with the arrangement of these particles. One cannot change the amount but one can change the arrangement of particles by cultural methods such as by plowing, cultivation, crop rotation, organic matter additions and use of light or heavy machinery.

Soil Structure Deteriorating

Some soils to which proper amounts and kinds of fertilizers are added, pesticides used and otherwise sound cultural methods employed do not produce satisfactory crop yields. It has only recently been recognized that decreased soil productivity often results from poor soil structure. Evidently, under most current farming practices, with increasing agricultural age, soil structure has deteriorated.

One way to get information on soil structure deterioration is to make comparisons between forested and cultivated soils. A way to get at this is to take a backward look and see how the soils were originally before the plow. Obviously, we can't turn back to the soils of the Pilgrims' time but we can examine forested soils and see how they compare with cultivated ones.

Studies by the Soils Department of this station show that many of Connecticut's soils to plow depth have lost a third of their organic matter, one-eighth of their nitrogen and that the cultivated soils weigh 2½ times more than forested ones. The poorest of the cultivated soils weigh 40 per cent more than the best.

The question naturally arises, "How did they get that way?"

Generally, the soils of Connecticut are of a sandy texture. Sandy loams and fine sandy loams predominate. In old glacial lake bottoms silt loams occur and on top of some drumlins loams are predominant. In glacial outwash areas the texture may be sands and loamy sands.

Under average forested conditions in Connecticut, leaf fall adds about 1¾ tons of organic matter per acre annually. This is equivalent to about a 12 ton annual application of manure. Seldom, however, are manure applications made to farm crops annually; more generally there is a three or more year interval between ap-

C. L. W. Swanson, chief soil scientist, The Connecticut Agricultural Experiment Station, New Haven, Connecticut. Mr. Swanson is a member of the SCSA and a frequent contributor to the JOURNAL.

plications and all too often, none is applied at all.

Before the advent of the tractor, we had horses and mules, and lots of them. The 1,000 tractors in 1910 grew to 3.6 million in 1950. The horse and mule population fell from 24 to 7.4 million. We lost manure and gained soil packers.

We can now stir up our soil easier and faster and can farm more intensively than ever before. Comparatively, in nothing flat we can run over our land to disc, harrow or cultivate it once again. We have overstirred our soils and oxidized out our organic matter. Comparisons between similar kinds of soils, one in forest and one cultivated, shows the forest to have 6.9 per cent organic matter and the cultivated soil 3.3 per cent. Many of our vegetable soils have little more than two per cent.

The Part Organic Matter Plays in Improving Soil Structure

What part does organic matter play in this deterioration of soil structure? It acts something like syrup in a popcorn ball. It sticks soil particles together into stable aggregates. Tight heavy soils become looser and lighter. Instead of being dense like a brick air spaces are added to the soil. Air can then get in and carbon dioxide produced by plant roots can get out. Literally, the soils can breathe. You know how you feel when you have a cold and your nose is stopped up. Maybe soils feel this way too and no wonder they have symptons of being sick and won't produce crops.

Adding air spaces to the soil means less erosion. Water can percolate through the millions of new holes instead of having to run off the land. In some studies by the Soils Department, soils in cutivation lost four times more soil than those in sod. Those in forest lost none.

The roots of sod plants and trees punch holes in the soil which aids soil drainage. The root system of a corn plant, for example, may occupy 200 cubic feet of soil. Alfalfa roots penetrate as much as 30 feet. If all the roots of a single crested wheat grass were put end to end, they would measure 360 miles.

Experiments on Tillage and Soil Structure

In recent years, the Department of Soils has conducted experiments on the effects of tillage on soil structure and crop growth.

During the summer of 1950 an experiment was carried out in which three methods of working the soil was practiced. The methods were as follows: Plowing nine inches deep, rototillering ten inches deep (fluffed soil up to 12 inches), and plowing with a TNT plow attachment which disturbed the soil 12 inches deep. The plots all received the same fertilizer treatment. The results were as follows:

Table 1.

Plowing Method Used	Marketable roots lbs. per Acre	Length of roots inches
Regular plowing	14,684	6.33
TNT plowing	15,706	6.69
Rototiller plowing	18,865	7.55

Results show that more marketable carrots were produced when the rototiller was used. In New York and Ohio similar results were obtained the first year but for succeeding years, yields were less for the rototilled plots in comparison with the other treatments. This is because the air space is increased the first year but the intensive beating action of the rototiller breaks down the soil structure the succeeding years.

An experiment in which weed control is accomplished by cultivation, scraping, 2,4-D, and 2,4-D with one cultivation is being carried out on the Mount Carmel Experimental Farm. Each of the treatments are replicated four times. A measure of the structural condition of the soil surface can be had with a penetrometer as shown in Figure 1. Measurements showed that 78 per cent more force was required to break the soil in the 2,4-D plots than in the cultivated ones. Measurements made at other depths show a plow sole to be clearly evident. The plow sole in this experiment was not broken up. It may be surmised from experimental evidence obtained elsewhere that the plow sole retarded root growth and infiltration of water to lower profile depths.

Differences of about 11 per cent in the amount of large pores in the surface two inches of soil gave 26 bushels more corn for the cultivated soil compared with that not disturbed for weed control. Plots in which 2,4-D was used and cultivated once emphasizes the importance of good structure in crop growth. Breaking of the surface crust produced a 16 bushel greater yield.

Nitrate nitrogen increased measureably following the breaking of the crust with one cultivation (Figure 2). The nitrate nitrogen content went up from 88 to 101 pounds per acre. Breaking of the surface crust permitted free movement of air into the soil and made conditions more favorable for nitrification. These comparisons were for plots which had not received manure but were otherwise fertilized the same.

The 1950 corn crop (grain, cobs and stover) was analyzed for nitrogen Table 1.

There are three separate rotations in the experiment: Corn, oats, and clover; corn and sunflowers; and continuous corn. The average total nitrogen content of all the crops growing in 1950 (corn, oats, clover, sunflowers) Table 2.

Since it is known that protein content increases di-

Table 2.

Treatment	Lbs. of nitrogen per acre in crop	Yield bushels per acre
Cultivation	137	123
2,4-D + one cultivation	131	120
2,4-D only[1]	119	112
Scraping only[2]	134	128

[1]Soil surface not disturbed
[2]Soil surface disturbed

Table 3.

Treatment	Lbs. nitrogen per acre in crop (grain, stover, hay, straw)
Cultivated	135
2,4-D + one cultivation	121
2,4-D only	115
Scraping only	125

rectly as nitrogen content increases, the food value of the cultivated corn was greater than for the others.

Tilth measurements made during the corn denting stage showed the cultivated soil to have a one-third better tilth index than the uncultivated corn, The looser, better aerated soil had more favorable conditions for producing soil nitrates as reflected in the yield and nitrate content of the grain. The corn plants were also taller, had thicker, more sturdy stalks, and a darker green color than those grown on soils with unfavorable soil structure. On the 2,4-D plots, undisturbed by the cultivator, a hard crust formed, while the soil on the cultivated plots was porous and in good condition. More striking than the variation in soil, however, was the contrast in the crop grown. The corn on the 2,4-D plots was smaller and lighter green in color.

Results were particularly striking during the 1948 and 1949 seasons of these tests. Both years had hot, dry summers, interspersed with infrequent but heavy downpours of rain which packed the soil surface. At the end of the 1948 season, the cultivated plots yielded 61.5 bushels of corn per acre, while the plots treated with 2,4-D produced only 15.2 bushels. Corresponding figures for 1949, when weather conditions were somewhat more favorable, were 94.6 and 68.3.

What Cultivation Does to the Soil

The question is often asked, "What does cultivation do to the soil, especially when tractors are used?" Some studies of this have been made by the Soils Department.

In 1948, comparisons were made between soils in bluegrass for 12 years and on adjacent plots which had been in cultivation during this time. Soil samples for physical studies were taken at a 0-2 inch depth in the bluegrass sod, in the cultivated area where no tractor wheel had run over the ground after the corn had been planted, and in the area at the end of the row where the tractor

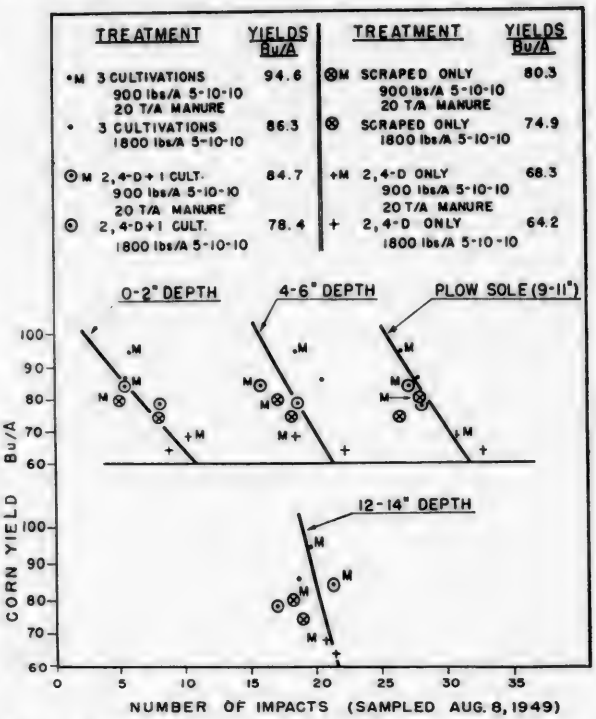


Figure 1. Effect of Cultivation on the Physical Condition of Soils on Corn Yield.

was turned around. Physical analyses showed that bluegrass sod had 68 per cent more macroporosity (large pores), 29 per cent more total porosity and weighed 25 per cent less than soils from the tractor turn-around area. For the cultivated area over which no tractor wheel passed after corn planting, comparative values obtained were 35, 9, and 7 per cent, respectively. This points out the effect of cultivation in loosening up the soil, providing no tractor wheel passes over the ground and it is not cultivated when the soil is wet. The data show strikingly the destructive action constant traveling over the land by tractors has on soil structure.

Soil Packing by Tractors

Studies were made in 1950 in adjacent plots on the packing effect of different weights of tractors on soils. Soil samples were taken in corn and carrot plots in the area traveled over by the rear wheel of the tractor and in non-traveled areas between plants. The crops were cultivated three times and samples taken after the last cultivation. In each cultivation, the rear tractor wheel travels over the ground twice both coming and going, cultivating two rows and next those adjacent. Therefore, the land was traversed six times by the rear tractor wheel.

A large tractor weighing 4,020 pounds with cultivator equipment was used on the corn plots, and a smaller

tractor with similar equipment weighing 1,140 pounds less on the carrot plots. Except for the crops grown, the soils in the plots had the same fertilizer and soil preparation treatments.

Soil core samples were taken at a 0-2 inch depth for structural analyses and the data obtained for the traveled and non-traveled areas compared. The following results show the effect of different weights of tractors running over the land:

Tractor weight, lbs.	Crop	Fertilizer	Per cent difference in macropores between traveled and non-traveled area
4,020	Corn	1,200 lbs./A 8-16-8	27
2,880	Carrots	1,200 lbs./A 8-16-8	22
4,020	Corn	600 lbs./A 8-16-8+	30
2,880	Carrots	20T Manure/A	8

These data bring out definite advantages of lighter weight tractors. In both fertilizer treatments, the soil was packed less by the lighter tractor, i.e., the differences in amount of large pores is less between traveled and non-traveled areas for the light tractor (22 and 8) in comparison with the heavier tractor (27 and 30). Where manure was used, the heavy tractor packed the soil four times more than the lighter tractor. These data also suggest that additions of organic matter help the soil resist compaction but it breaks down under heavy weights. In other words, organic matter has a cushioning effect but that this cushioning effect is overcome by too heavy weights.

In 1949, the Soils Department devised an apparatus, called a penetrometer, for measuring the compaction of soils. The cushioning effect of organic matter is demonstrated by some analyses made on the structure plots at the Mount Carmel Farm mentioned above. The amount of force required to drive a 3 5/16-inch cutting cylinder 3⅜ inches into the soil in the tractor wheel area and non-traveled area in corn plots was measured. In plots receiving 20 tons of manure and 900 lbs. of 5-10-10 on an acre basis, 39 per cent more force was required in the tractor wheel area than in the non-traveled area; plots receiving no manure but 1,800 lbs./A of 5-10-10, 110 per cent more force was required. This was the first year of the experiment, the soil having had the same cultural treatments for at least five previous years. Because the fertilizer treatments are not identical, yield differences would not be comparable.

Plow Sole Hardness Compared With Soil Below and Above it

Measurements were made of the hardness of the plow sole and also below the plow sole. For plots receiving manure, 48 per cent more force was required to drive the penetrometer 3⅜ inches into the plow sole in comparison with soil about 4 inches below it; for the non-manured plots, it took 77 per cent more force.

Comparisons were also made with the surface. On the non-traveled area of the manured plots, the surface 3⅜ inches of soil was 344 per cent easier to penetrate than the same thickness of plow sole; for the tractor wheel area, the difference was less, being 219 per cent, since the running over of the ground by the tractor had packed the soil. In the case of unmanured plots, the results were 459 and 167 per cent, respectively. Again, the unmanured soil showed less resistance to packing and general soil deterioration than the manured soil.

Soil Erosion in Connecticut

Three independent surveys of erosion conditions in Connecticut have been made by United States Department of Agriculture and The Connecticut Agricultural Experiment Station soil scientists. The estimates are given below.

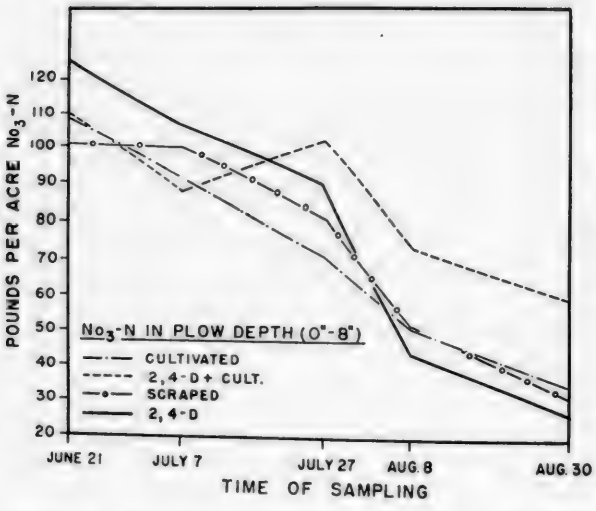
Comparison of Erosion Measurements in Connecticut

Erosion Class	Scantic River Area		Farm Muddy River	Group Estimate
	Entire Area %	Excluding Woodland %	Excluding Woodland %	Entire State %
Slight	68.1	78.3	44.2	66.7
Moderate	31.2	20.6	48.8	31.6
Severe	0.7	1.1	7.0	1.7
	100.0	100.0	100.0	100.0

From these data, it is apparent that little severe erosion exists in Connecticut, about one-third of the land is moderately eroded, and on two-thirds of the land there is little erosion. These data are in agreement with the fact that about 61 per cent of Connecticut is forested, a vegetative condition under which little erosion occurs. The severely eroded areas are localized in the potato and vegetable growing areas, principally in the Connecticut and Quinnipiac valleys.

Connecticut is fortunate in not having a major erosion problem such as occurs in some parts of the United States. Some reasons for this are the generally sandy nature of the soils which allows quick infiltration of water, moderate intensity of rainfall, predominance of dairying, fruit and tobacco agriculture which use practices that keep soils covered a maximum amount of the time, and the large non-agricultural areas (forestry, 61 per cent) in the state.

One of the most erosive soils in Connecticut is the Enfield very fine sandy loam. This is partly explained by the high silt and very fine sand content in about the first foot and one-half of soil. In this layer, over 50 per cent of the soil is silt and about 18 per cent very fine sand. This



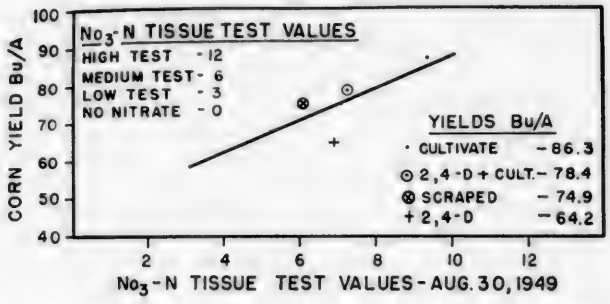


Figure 2. These graphs show the relationship between the amount of nitrates in the soil and that taken up by the corn plant. Corn in the cultivated plots took up the most nitrogen there being little left in the soil at the end of the growing season. Breaking of the soil crust on July 7 increased the amount of nitrogen in the soil as measured on July 27 for the 2,4-D plus cultivated corn.

compares, for example, with about 35 and 13 per cent, respectively, for a Cheshire fine sandy loam. The Enfield also has less coarse sand, gravel and rocks than the Cheshire soil. These differences in physical composition are reflected in the flow of water through the soil.

The rate with which water drains through a soil is determined by the ease with which the water can enter the surface horizon. The infiltration rate for the Enfield is 3.6 inches per hour for the surface horizon and for the Cheshire soil 10.0 inches per hour. The Cheshire soil has a greater capacity for soaking up rain water than the Enfield. The Enfield will become saturated quicker and the excess rainfall will flow down the slope, causing erosion. Some soils, like the Wethersfield and Paxton, also erode quite easily because at about 18 inches a compact layer stops water from filtering through the soil.

Soil Clay Mineralogy Studies

X-ray diffraction work on the clay minerals of two representative soils, the Merrimac and the Wethersfield, show illite to be the predominant clay mineral. Chlorite, montmorillonite, vermiculite and kaolinite occur in smaller amounts.

Only from six to 10 per cent clay occurs in most of the soils of Connecticut. This small amount of clay together with a generally infertile kind of clay explains the native infertility of Connecticut's soils. Illite does not have a marked ability to hold plant nutrients like calcium, magnesium and potassium from leaching out of the soil. The high sandy and low clay content of the soil coupled with the relatively high annual rainfall (45 inches) is conducive to excessive leaching. Another criterion of rapid and easy movement of materials in the profile is the lack of any accumulation of silica, iron or manganse oxides in Connecticut's soils. Not more than one per cent accumulation of these materials was found in any of the horizons of the Merrimac and Wethersfield. In many soils, there is a zone of accumulation of these materials.

Studies on Manure Substitutes

With a third of the original organic matter depleted and our soils being packed more each year by intensive cultivation, there is need for replenishing the organic matter supply. Rotating row crops with legumes and grasses will provide organic matter and improve their physical quality. Other sources of organic matter are barnyard and organic materials like peat, tobacco stems, wood chips and sewage sludge. These latter materials can be used especially in intensively cultivated crops.

Experiments on Merrimac sandy loam at the station's Tobacco Laboratory in Windsor show the value of using organic materials in vegetable production. Native peat, sheep manure, native peat moss, commerically processed cow manure and tobacco stems were applied at about a 2½ ton per acre water-free basis. These organic materials were balanced with commercial fertilizers to obtain a total annual application equivalent to 2,000 pounds of 5-5-10 grade fertilizer per acre. These organic materials were compared for a 9-year period with equivalent rates of inorganic fertilizer alone in growing cabbage, sweet corn and carrots.

In general, the organic materials plus fertilizer produced substantially larger yields than did fertilizer alone. Commercially processed cow manure gave the highest increases with a 40 per cent yield increase for sweet corn and 35 per cent for cabbage. For sheep manure, native peat moss, and native peat, the increase was 25 per cent for sweet corn. It was about 25 per cent for cabbage using native peat moss, sheep manure and ground tobacco stems, and 30 per cent for native peat. Response of carrots to organic materials was not as great. Seven

to 16 per cent yield increases were obtained with sheep manure, native peat moss, native peat and commercially processed cow manure.

Changes in soil organic matter resulted from these treatments. The original amount was about two per cent. Native peat, native peat moss and commercially processed cow manure added 1,900, 1,600 and 840 pounds per acre annually. Tobacco stems, sheep manure and fertilizer alone treatments gave annual losses of 400, 435, and 740 pounds of organic matter. The more resistant materials added organic matter and those which decomposed easily and quickly decreased the amount in the soil. Since the latter ones decompose quickly, perhaps larger amounts need to be used.

Decomposition of organic matter is beneficial since this provides food for soil bacteria. If soil bacteria are inactive, plant nutrients will not be made available to plant roots. Another beneficial effect of organic matter is the holding of plant nutrients, especially nitrogen, from leaching. It also increases the water-holding capacity of the soil and sticks the single grain structure of sandy soils like the Merrimac into aggregates.

Work done at New Haven on the value of wood chips in soils shows that they can be used to loosen up soils by decreasing their weight per unit volume, and the water-holding capacity may be increased as much as one-fourth. At least one pound of nitrogen for every 100 pounds of dry chips need to be applied for meeting the nitrogen needs of the soil bacteria in decomposing the chips.

Sewage sludge experiments show that it can also be used as a soil conditioner. Some sludges are low in pH and care must be taken that lime is added, otherwise toxic elements like copper and zinc in the sludge may produce deleterious effects on the plants.

Improved Soil Structure Increases Yields and Decreases Erosion

It is quite evident that Connecticut's intensively cultivated soils are generally low in organic matter. Because of reasons pointed out above, most of Connecticut's soils are not highly erosive. However, if organic matter supplies are not replenished by rotations including legumes and grasses or by organic amendments such as manures, wood chips, sludge, peat, etc., it can be expected that crop yields will decrease as a result of decreased soil productivity brought about by a general deterioration of the structure of soils. With poorer structure, one can expect increased erosion losses.

Increased productivity and decreased erosion generally cannot be expected to be achieved only through the establishment of conservation measures such as terracing, strip cropping and the like. They need to be combined with good organic matter and soil improving practices. Fertilizers will have to be used to provide the plant nutrients naturally lacking in our soils. Later perhaps, terraces, etc., may be dispensed with after the structure of the soil has been built up. Considerable evidence exists from the researches mentioned above that organic matter promotes good soil tilth, increases soil productivity and water infiltration and decreases the packing effect of tractors.

Multiple Use and the SCSA

(*Continued from page* 119)

and intangible values dependent upon its adequate and continued care, require public ownership and effective administration of certain areas for the public welfare as a whole.

Inadequate knowledge remains a major obstacle to the fuller application of the multiple use principle. For example, considerable damage to soil-water relations—as evidenced by aggravated flood flows, sedimentation, and other water problems, and by the lowered productivity of the land for timber, forage, wildlife, and other crops and services—often result from the effects of logging, road building, grazing, and cropping systems where these relationships are inadequately understood. As a result, many landowners and operators, as well as technicians, tend to overemphasize the more immediate, direct and readily visible values at the expense of others whose worth may actually be far greater. The Soil Conservation Society, by reason of its viewpoints and the highly varied complexion of its membership, is in a unique position to cooperate with other groups in overcoming this deficiency.

The Society's meetings, publications, and technical committees in such fields as watershed management, land classification, and technical standards provide media whereby the practical forester, who is or should be concerned over the watershed effects of logging, forest-grazing, fire, planting, etc., can benefit by the knowledge of others more skilled in interpreting soils and water flow. Similarly, those interested in the practical application of soil and water principles can benefit from the experience of foresters and others skilled in handling the land.

In conclusion, the efforts of the Fourth American Forest Congress to formulate and promote programs which recognize the value of commercial as well as non-commercial forest lands for watershed protection, wildlife, recreation, and other related values closely accord with the aims and program of the Soil Conservation Society of America.

Book Reviews

THE FLOOD CONTROL CONTROVERSY *Big Dams, Little Dams, and Land Management,* BY LUNA B. LEOPOLD AND THOMAS MADDOCK, JR. *The Ronald Press Co., New York, 1954. $5.00. Sponsored by The Conservation Foundation.*

Flood plains are very attractive to man. Farmers find the soil rich, easily worked and highly productive. Towns arise on rivers for obvious reasons; they provide a means of cheap and easy transport; they provide much needed water for domestic and industrial purposes, and a handy means of waste disposal. Rivers and their valleys also are obstacles across which man throws bridges and along which he builds structures to serve his commercial needs as towns grow into cities. Briefly, for a variety of advantages, man encroaches upon the river itself and its flood plain. He should know the risks involved. The farmer may meet them by placing his buildings on the upland and writing off the occasional flood damage to crops against the normal high productivity of flood plain soil. But the town and the city with their needs spread onto the flood plain and onto the channel itself, endeavoring to protect themselves by engineering works, for everyone knows or eventually learns that high water and destruction are always a threat. Real estate values are high along the river, memory is short, confidence in engineering and luck are high, knowledge of rivers and their behavior is short—men take risks and look to the government for protection.

Of course flood damage is increasing. The value of property subject to flood is increasing. Every passing decade a comparable flood on the same river causes a greater loss of property and perhaps of life. The need for protection becomes greater, and the pressure on the government to do something becomes irresistible. Flood control has become big business. And by and large it is met mainly in one way—by engineering efforts to convert the natural stream with its channel and flood plain into a large conduit with, here and there, dams and catchment basins to hold back excess water until the channels can carry it off.

The Federal Government with its responsibility for navigable waters has taken on most of the responsibility for flood control (a misnomer, of course) and assigned the duties to the Corps of Engineers. Levees, dikes, and diversion channels offer few complications, but big dams are attractive and the Army learns fast. They provide some protection from flood damage. They can also be constructed for multiple purposes—for hydro-electric power, for irrigation, for recreation. They bring big money into an area; something no congressman can resist.

Reservoirs catch silt. The "half-life" of a reservoir varies from a few decades to a few centuries and it is seldom economic to rejuvenate their capacity for water storage. Such possibilities as there are for prolonging the life of a reservoir lie on the watershed.

The Department of Agriculture quite properly carries out its work on the watershed and feels that a reservoir is a poor place to store top soil. Especially since the advent of the Soil Conservation Service there has been much activity and many claims for land management—the slowing of erosion, the slowing and reduction of water run-off and increase of infiltration, and thereby the maintenance of soil fertility and productivity. Reservoirs fill less rapidly and flood damage is reduced. These are the claims, and sometimes the facts. But land management has little if any effect on major floods on large streams and insufficient control of heavy rains even on small streams, important as such practices may be for soil protection and agriculture. So the Department of Agriculture has discovered the additional need for engineering works—upstream engineering on the land and small dams on the smaller streams where, collectively, the greater but less spectacular flood losses occur.

In effect, as the Corps of Engineers has broadened its scope and incorporated multiple-purposes in its works and has migrated headward along America's streams, and as the Department of Agriculture has incorporated engineering within its scope and migrated downstream, the two agencies have come into competition and conflict. Out of this situation arise the incompatible claims and the controversy which are the subject of the book by Leopold and Maddock.

The authors' book, which is one of a growing series of extremely valuable studies sponsored by The Conservation Foundation, is about the controversy. But it is not a polemic. It does not plead either case. It provides the available facts. It is shown that the program of neither agency is adequate alone, that upstream and downstream works are not interchangeable for they serve different purposes.

Part I states the problem; Part II discusses downstream programs for flood control; Part III considers upstream programs; and Part IV goes beyond the controversy. In the dozen or more chapters one finds the data one needs, in so far as they exist, about hydrology, engineering, soil and crop practices, the economics involved, agency policies and administrative problems, the needs of people, and the facts of politics.

Although at times one feels like "a curse on both your houses"—the Corps and the Department, the Democrats and the Republicans—this book on "*The Flood Control Controversy*" leaves one with a well-founded hope that things will be different. Here are facts and a cool appraisal. If the agency people will read this book, if the

politicians will read it, and if the people—enough of them—will read it and let their judgment be known, there is hope for rational solutions of many of the problems. And these solutions will come from actions by the people (in small watershed associations and local government) and actions by the large Federal agencies (The Corps of Engineers and the Departments of Agriculture and Interior), each playing the appropriate role. But in all this there are great difficulties arising from the glamor and political attractiveness of big dams and from the need for an enlightened citizenry willing to accept individual, state, and local responsibilities as well as to clamor for "state's rights."

This is the most important book yet in the flood control field, and if it becomes a model for other books, it may well be the most important book yet in conservation and resource management.

—STANLEY A. CAIN, *Ann Arbor, Michigan*

GRASSES AND GRASSLAND FARMING. *By* H. W. STATEN. *Devon-Adair Co., New York. 1952. 310 pp., illus. $5.00.*

The growing interest among agriculturists, both theoretical and practical, in grasses and grassland farming has brought forth a corresponding abundance of books on the subject. One suspects that a professional worker of any prominence in this field with no claim to authorship must feel an uneasiness in the presence of his colleagues.

Nevertheless, this prolific literature is serving at last to give a most important matter the emphasis it deserves. Something more than money profits is at stake; the very permanence of American agriculture depends upon a proper appreciation and adequate practice of grassland husbandry. That it is profitable, of course, is a necessary prerequisite to its successful practice.

Professor Staten by his title, "*Grasses and Grassland Farming*" alerts the reader to his intent to cover the entire field in his book. This he does, as a scanning of the table of contents will show, and with the profit motive getting a leading emphasis.

Noting that in 1948 the gross income from livestock in the United States was 17 billion dollars, of which $8½ billion was contributed by grass, he establishes the point that grass is big money—bigger, in fact, than mining ($4 billion) or automobile manufacturing ($7 billion).

But, we are running out of grass, Prof. Staten warns. The grazing capacity of the western range today is little more than half the original. Acreages of native grass have been drastically reduced, and pastures of the East and South have deteriorated to mere patches. Far too little is being done by public agencies in the way of research and improvement programs on grass.

From this taking-off point, Prof. Staten proceeds to recount instance after instance of farmers and ranchers who have practiced good grass management and reaped good profits. He discusses in order pasture improvement, pasture management, year-round grazing, revegetation, the evils of burning, grass for erosion control and soil building, and the production of grass seed. Then he singles out, describes, and evaluates a number of important grass species of the northeast, the cotton belt, the prairies, the plains, and the far west. He concludes with a discussion of introduced grasses and grass breeding.

If his academic position were not identified on the title page, the reader would scarcely suspect that the author is a professor (of agronomy, at Oklahoma A. and M. College.) The book is written as a layman speaking to laymen, as one stockman to another. Some colloquialisms may seem awkward to unfamiliar ears, but the point is always clear.

The account naturally is colored by the author's own unique viewpoint and experience, that of an agronomist not primarily trained in the sciences of agrostology and range management. Technical men, no doubt, will find points over which to quibble, and ecologists may wince at the unorthodox use of some of their sacred terms.

But the theme of the book is unmistakable, and its truth inescapable—that American agriculture needs more grass, and that grass pays handsomely in return for good management.

—BEN OSBORN, *Midland, Texas*

ECONOMICS OF SOME SOIL CONSERVATION PRACTICES. NORTH CENTRAL REGIONAL PUBLICATION No. 44. *Iowa Agricultural Experiment Station Research Bulletin 403. Ames, Iowa, December 1953.*

This is the third bulletin on soil conservation produced by the North Central Farm Management Research Committee. Its objective is to evaluate individual conservation practices and to illustrate the costs and benefits of these practices under certain specified conditions. In presenting data on individual practices, the authors specify that the report is not an exhaustive study of all available experiments, and that research information is inadequate to answer all questions on the economics of conservation. However, readers of the bulletin will find it a store of information on costs and benefits of contouring, terracing, grass waterways, strip cropping, mulch tillage, drainage, and irrigation. The place of rotations will be discussed in a later publication. Experimental results from Illinois, Indiana, Iowa, Kentucky, Minnesota, Missouri, Nebraska, Ohio, South Dakota, and Wisconsin are reported.

Costs of practices are given for the time and place where experiments were carried out, and both cash costs and labor requirements under different methods of construction are reported. Benefits from practices are re-

ported in terms of crop yields and soil losses wherever possible but the more intangible benefits are also considered. For example, contouring increased corn yields as much as 14 per cent on a three-per cent slope and reduced soil losses from nine tons to less than one ton per acre. Contouring also allowed a more intensive rotation under given erosion hazards. The benefits from such practices as grass waterways are more difficult to measure, however, as they are tied in with all the other erosion control practices on the farm. Waterways reduce soil loss and make for easier farm operation by allowing machinery to be driven through the waterway.

One of the most significant points of the bulletin is that farmers generally have a rather wide choice of methods of erosion control by various combinations of land use and other conservation practices. The best plan for one farmer may not be best for his neighbor on a similar farm because of differences in managerial ability or available capital. Also, the degree of conservation desired by society may be greater than that desired by the individual farmer. Price relationships may not encourage individual efforts for conservation, and legislation is often needed to protect the long-run interests of society.

This bulletin should be helpful to farm planners in helping the farmer make decisions and also to research workers who need a concentrated source of information on conservation practices.

—W. H. HENEBERRY, *Urbana, Illinois*

OUR WILDLIFE LEGACY, *By* DURWARD L. ALLEN. *422x pages. Illustrated with 24 half-tones. Published by Funk and Wagnalls Company, 153 East 24th Street, New York City. 1954.*

Tremendous progress has been made within the past three decades toward an intelligent public appreciation of the problems involved in the management and administration of North America's wildlife resources. A major deterrent to still greater progress has been a conspicuous lack of individuals with a firm grasp of the biological facts who are capable of reaching the public through the coherent written page. Articles or books written by the average biologists too often appear stilted and pedantic and lack totally that all-important ingredient of reader appeal—except to other biologists. Manuscripts prepared by the professional writer often contain a wealth of reader interest and an equal abundance of half-truths and outright fiction.

In this book, as in many earlier writings, Dr. Allen proves himself to be an outstanding exception. An eminently qualified authority by virtue of 20 years of experience in state and federal game work, he translates complex ecological facts into dramatic incidents and bald statistics into down-to-earth prose.

While written primarily for the layman, this book should appeal to anyone interested in wildlife whether as a sportsman, amateur naturalist, or professional biologist. For the soil conservationist, forester, or agriculturalist who must face wildlife problems in his work this will prove the clearest and most readable reference which has appeared in print to date. Problems of crop damage by deer and other wildlife are analyzed carefully, accurately, and unemotionally; the interrelationships of animal abundance and land use are discussed intelligently; and there is an excellent evaluation of such worn-out panaceas as the county system, the buck law, and indiscriminate restocking. How anyone could advocate these practices as the cures for all wildlife ills after reading Allen's thorough deflation of them is difficult to see. At the same time, the author never fails to make clear the fact that there are situations under which the buck law, predator control, and restocking may be valuable methods for increasing beneficial wildlife populations. Like all practices, however, these are tools of management to be used by the wildlife technician as discriminately as a carpenter uses the various instruments in his own tool kit. The theme of the book, emphasized in every chapter, is that wildlife, properly regulated, is a valuable national asset which exists under basic natural laws in an environment largely under the control of man. We can squander this legacy recklessly as was done by our forefathers in the first centuries of this nation's history, or we can maintain it at optimum levels of high usefulness. The principal investment needed to continue drawing interest in the form of abundant recreation and esthetic appeal consists of public understanding of the problems involved. Durward Allen's book is recommended highly as a valuable contribution toward the realization of that goal.

—JAMES B. TREFETHEN, *Washington, D. C.*

CONSERVATION LAW AND ADMINISTRATION: *A Case Study of Law and Resource Use in Pennsylvania. By* WILLIM F. SCHULZ, JR. *The Ronald Press, New York. 607 pp. 1953. $10.00.*

This comprehensive study of the legal and administrative aspects of the use of renewable natural resources in the State of Pennsylvania, jointly sponsored by the Conservation Foundation and the University of Pittsburgh School of Law, is an unusually interesting and informative work of much greater scope than the title implies. The study is raised clearly above the "refence work" class through extensive use of historical material, careful analysis of the many forces shaping Pennsylvania's legislative and administrative development, and the consideration of many conservation problems that are in no way unique to Pennsylvania. Both state and federal legislation are assessed in such areas as wildlife conservation

and game laws, water resources, soil conservation, and forest resources.

Chapters on "*Recreation*," "*Conservation Education*," "*Legal Devices for Resource Conservation*," and "*A Model Act for Conservation Administration*" contain material which is equally pertinent for other areas of the United States. The development of Pennsylvania's legal and administrative organization for resource control has taken place under unusual circumstances—both in terms of the abundance of resources and the high qualities of many of its leaders, such as Pinchot and others—with the result that its experience may be of unusual importance as a guide for other states.

Particular mention should be made of the Model Act for Conservation, which should be helpful to any agency or state truly interested in avoiding the errors of the past and promoting the most effective administration and use of our natural resources. It is such original material as the Model Act that makes this book an important source of information for the intelligent layman as well as a contribution of significance for the specialists in the fields of conservation and administration.

—L. G. HINES, *Hanover, New Hampshire*

WORLD POPULATION AND PRODUCTION. *By* W. S. AND E. S. WOYTINSKY. *Twentieth Century Fund, New York. 1953. 1268 pages; 497 tables; 338 charts and maps. $12.00.*

This prodigious study is an attempt to survey the needs and resources of the whole world and to discover significant trends in the pattern of the present era's economic activity. The work under review, to be followed shortly by a companion volume on *World Trade and Organization*, consists of an extensive investigation of the major aspects of mankind's material welfare. The first section on Man and His Environment contains a detailed survey of the growth, distribution, and composition of world population and an estimate that by the year 2000 over 3,250 million individuals will inhabit the earth, with the so-called underdeveloped areas of the world contributing the major share of this increase.

World Needs and Resources are considered in the second section of the study along with such related topics as national income, consumption standards, human resources, national per capita income variations, and the like. The importance of agriculture in world production —six out of ten persons gain livelihood from farming— leads to separate treatment of this industry. Excellent material is included in this section on the comparative position of agriculture in different parts of the world, food crops, livestock, and animal products, together with an appraisal of the related renewable output of forests and fisheries.

The status of the world's exhaustible resources are surveyed in Part IV, along with an analysis of the general problems of extractive industries, such as metallic ores, and the economics of energy fuels, such as petroleum, natural gas, and coal. The last section on Manufactures in the World Economy investigates the selected industries of food, textiles, iron and steel, chemicals, machinery, and transportation equipment.

Although *World Population and Production* is much more than a reference book, the very encyclopedic nature of the presentation will discourage all but the most resolute from using it as anything other than a source book for special information. Whether approached as a reference work or as an addition to our meager knowledge of the nature of the future struggle for material welfare, however, this book is a very notable contribution.

—L. G. HINES, *Hanover, New Hampshire*

INDIAN LAND AND ITS CARE. *By* EDGAR L. WRIGHT, DAVID P. WESTON, AND CLYDE W. HOBBS. *Department of Interior, Bureau of Indian Affairs. The Haskell Press, Laurence, Kansas, 91 pages. 1953. 40 cents.*

Not much is known by the American public about Indian lands. Through this concise booklet we obtain some insight on the problems faced on western Indian lands. Although largely prepared by specialists of the Branch of Soil Conservation of the Bureau of Indian Affairs, many other individuals, including educators, contributed.

The purpose, as stated in the Foreword, is "*to inform Indian school children and their parents of the condition of Indian land in the United States* [*western states*] *and to outline the methods used to maintain and improve the productive capacity* [*agricultural-wise*] *of these lands.*"

The teacher is definitely considered the "key" person in introducing the lessons of the booklet, and has been given, "for the most critical land problems," a useful guide. Ten pages are devoted to conservation education methods: field trips, community meetings, radio, press, exhibits, classroom demonstrations, outdoor classes, visual aids, and use of local materials and technicians. This portion of the booklet is worthy of being reprinted and widely distributed by educational agencies. It is one of the better and more concise that I have yet read concerning methods.

Because one must live closely with local situations to understand such, I can only raise the question of why must wildlife be treated largely as "pests"? On the 56,000,000 acres of Indian lands, throughout the United States, there are still substantial portions whereon game and fish furnish excellent food and recreation. Teachers in the Bureau of Indian Affairs would do well to broaden these concepts of wildlife, lest a generation grow up re-

garding most wildlife as "pests."

Although I failed to understand what was meant by "normal conditions," I did cheer when I read, on page 21, that, *"Under normal conditions, predatory animals, like wolves and coyotes, help in controlling rabbits."* This is progress.

To those of us several thousand miles away from western Indian lands, and other western lands, it is important that we gain a simplified insight on some of the problems that must be met as a growing human population places increased demands on a land and water base. And, about Indians and the lands they now try to use, we have a deep moral obligation to become informed. Problems involving land, water and human populations have become universal.

—DOUGLAS E. WADE, *Columbia, S. C.*

GRASSES INTRODUCED INTO THE UNITED STATES. *By* FRANCES WEINTRAUB. *79 pp. U. S. Department of Agriculture, Forest Service Agriculture Handbook No. 58.*

This handbook is an annotated list of over 400 grasses that have been introduced into the United States. The entries are made alphabetically by generic and specific names. Also, the common names of species are given where they exist. A rather complete bibliography consisting of 218 references lists the grasses alphabetically by scientific name; following each name are given the references that apply to that particular grass. An index of common names also is included.

This booklet should prove helpful to conservationists, range men, agronomists, and to agricultural workers in general. It is the only work of its kind to which one can turn for brief, concise information on the subject. For a good many grasses the notes are brief, listing for each merely its source, occurrence in this country, and relative abundance. For others a more complete treatment states growth and seeding habits, habitat or site requirement, general and special uses, geographic range, special adaptations, and the listing of selections and strains where they have been developed.

Although the list of introductions is large it is not complete, for it includes only "species of demonstrated economic value as well as those now believed promising." Concerning the origin of these "foreigners" it is interesting to note that approximately 150 came from Europe; 100 from Asia, Eurasia, Asia Minor, and Russia; 50 from South America and Mexico; 50 from Africa; 30 from China and India, and 14 from Australia.

The author presents the following statement in the introduction: "In setting up this list, an effort has been made to clarify nomenclatural confusion." Apparently this effort was restircted wholly to scientific names, for the list does not clear up the confusion relative to common names. From the standpoint of practical application to pasture, range and associated soil-management practices, common names assume equal or greater importance than scientific names. The author made an attempt to supply common names wherever possible, but if an established authority is used as a guide to these common names, it is not mentioned.

It appears rather that a number of refences were used. In the case of various species of Bromus, as an example, the common names from *Standardized Plant Names, Hitchcock's Manual of Grasses,* and *Gray's 8th Edition of Field Botany were used.* In the interest of uniformity and general acceptance of the use of common names, would it not have been more desirable to use *Standardized Plant Names* and cited it as a reference?

Another criticism offered here is that of accuracy of content. In dealing with a group of grasses of which little is known and less is recorded in published writings, one tackles a difficult job to assemble such facts and publish them. It entails a great deal of searching through sometimes obscure literature, as well as time-consuming correspondence. At times one wonders whether it is safe to write anything at all. Rather than present nothing whatever, in a few cases the author has invited comment by including some misleading information. Under crested wheatgrass, for example, the statement is made: "The Fairway strain—is the commercial form of this species and the one commonly used in revegetation." This is correct if the author had stated "in Canada," for in the United States the Standard Strain is in common use. Another case in point is the account on Ree wheatgrass which is given as a hybrid of intermediate wheatgrass and pubescent wheatgrass. This statement is apparently based on an earlier reference which to our best knowledge, however, has been found incorrect. Other examples could be cited from this booklet, but these are sufficient to illustrate the difficulty one encounters in writing on this subject. There is little excuse in perpetuating error, neither is there a substitute for experience gained from working with the material one wishes to write about.

—A. D. STOESZ, *Washington, D. C.*

IMPACT OF THE PROPOSED LIBBY DAM UPON THE FOREST ECONOMY OF LINCOLN COUNTY, MONTANA. *By* C. S. WEBB, WARD W. GANO, PAUL LOGAN, AND S. BLAIR HUTCHISON. *Mimeo. by Forest Service, U. S. Department of Agriculture, Missoula, Montana, 1953.*

A feature of the modern West is the building of great dams to harness western rivers. Dams like Shasta, Boulder, and Grand Coulee have demonstrated their value to the West and to the nation by controlling floods, irri-

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gating productive land, and supplying electric power for cities and industries.

The planning of such projects includes detailed calculations of benefits and costs. Among the less apparent costs is that of recompensing local economies for resources or services that are inundated or otherwise lost as a result of the project. In the forested mountains of the Northwest, often the dominant value lost is the timber resource upstream of the dam. Not just the timber that is inundated by the reservoir itself: even more, the mountain areas of forests that are isolated or made less accessible for fire protection or the harvesting of timber.

This problem became conspicuous with the design and construction of the Hungry Horse Project in Montana. There it became evident that in future projects of this kind it would be necessary to provide adequate compensation to the local economy: especially through the rebuilding of roads and other transportation facilities. For this purpose, a conventional method has been "replacement in kind": sometimes interpreted as building another road outside the reservoir area, equal in standard to any inundated road. But in the timbered mountain country this method is obviously inadequate, because a winding mountain road along one side of a reservoir could not replace the services given by a straight, water-grade road tapping both valley walls.

Exactly this problem was encountered when the Libby Project was contemplated in northwestern Montana. Because of its importance to the local and regional economy, the problem was faced squarely by the responsible Federal agencies. With sponsorship and funds from the U. S. Corps of Engineers, a detailed analysis was made by the Forest Service (U. S. Department of Agriculture), resulting in this report.

Briefly, two alternative dam sites were considered, both above the town of Libby, Montana. Three possible solutions were considered for one site, and two solutions for the other. Each consisted of a road system designed to replace the services which would have been supplied by valley-bottom transportation. Combinations of water transportation in the reservoir with these roads were also considered. For each transportation system the installation costs and the annual costs of log hauling and other traffic were estimated. It was shown conclusively that the cheapest road system from the standpoint of original construction cost was actually the most expensive in the long run because it greatly increased the cost of timber production and community business in general.

The construction cost plus operating cost for the most economical transportation system for the lower dam site was found to be $611,400 annually. For the upper site the corresponding figure was $432,800.

A reasonable answer to the transportation problem was reached for each of the two dam sites: it is a combination of a well-considered road system with some water transportation. Even so, the solution for the lower dam site is estimated to cost $611,400 more on an annual basis than equivalent transportation would have cost without the dam. For the upper site, the corresponding figure is $432,800.

These factual solutions in themselves are a real achievement. But even more important is the philosophy that the solutions represent. Through their realistic approach to this concrete problem, the two federal agencies involved have made a great forward stride toward the unbiased appraisal of all the impacts of water development projects upon local and regional economies. It is to be hoped that other project-planning agencies will adopt a similar viewpoint, and that this kind of approach can be applied to a broader realm of impacts, both tangible and intangible, of river-basin development projects and programs.

—H. G. WILM, *Syracuse, New York*

Guides for Conservationists . . .

The Flood Control Controversy

Big Dams, Little Dams, and Land Management

LUNA B. LEOPOLD, *U. S. Geological Survey;*
THOMAS MADDOCK, Jr., *U. S. Bureau of Reclamation*

JUST PUBLISHED—This thought-provoking book clarifies both the technical problems and the economic and political issues in flood control. It explains the nature of river floods and the types of control measures possible. It evaluates the upstream and downstream programs advocated by the Department of Agriculture and the Corps of Engineers, comparing the different methods used by these federal agencies in planning and justifying their programs. The volume assesses present control measures, presents hydrologic considerations often overlooked, and weighs the merits of current and proposed flood protection measures. *A Conservation Foundation study. 19 ills., 12 tables.* **$5**

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Dr. Firman E. Bear to Retire June 30; Past President, SCSA

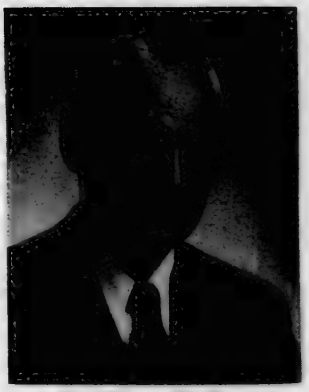
Dr. Firman E. Bear, professor of agricultural chemistry and chairman of the Soils Department at the New Jersey Agricultural Experiment Station, Rutgers University, since 1940, will retire on June 30. He will be succeeded by Dr. Russell B. Alderfer, professor of soil technology at Pennsylvania State University.

Dr. William H. Martin, dean and director of the College of Agriculture and Experiment Station at the State University, in making the announcement said that Dr. Bear would continue as editor-in-chief of Soil Science and would maintain an office on the campus. This scientific journal is recognized as the leading publication in its field and attracts contributors from all over the world.

Immediately following his retirement Dr. Bear will spend some time in South America, stopping in Peru, Chile, Argentina, and Brazil.

The Soils Department has 13 full-time professional staff members, about double what it had when Dr. Bear took over 14 years ago. Graduate work has grown from almost nothing (two students in 1940) to a point where 25 young scientists are carrying on research projects and studies which will lead to doctor of philosophy degrees. One man is engaged in post-doctoral work.

"Much of this growth has been made possible by the generous support given to the department by individual corporations, foundations and others," Dr. Martin said. "Last year grants from these sources totaled more than $100,000, including the high esteem in which the work of Dr. Bear and his associates is held.

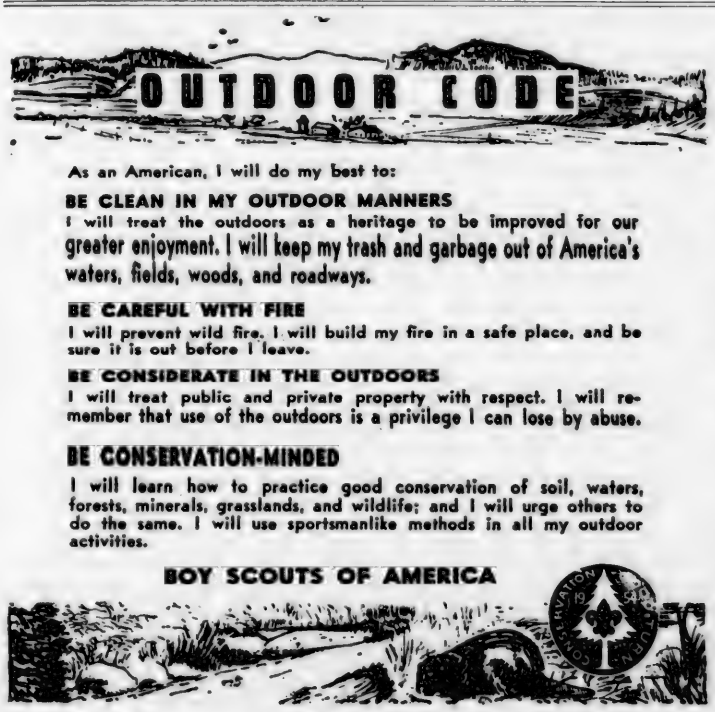


Dr. Firman E. Bear

"Perhaps most outstanding of the many accomplishments of the Department of Soils in recent years has been the work with trace elements —boron, molybdenum, iron, manganese, sinc, and copper. Plants and animals require only minute quantities of these elements for healthy growth but deficiencies may lead to serious troubles," Dr. Martin explained.

"Crops of cauliflower, for example, have been rendered largely unmarketable because of a deficiency of one of these trace elements—molybdenum—in the soil. The plants produced 'whiptails' instead of salable heads. Boron deficiencies ruined crops of celery, cabbage, turnips and other vegetables, until Dr. Bear and his staff discovered the cause and cure. Their research investigations have prevented losses of farm crops which might have run into many thousands of dollars each year in New Jersey alone."

Dr. Bear is past president and fellow of the American Society of Agronomy, past president of the Soil Science


OUTDOOR CODE
As an American, I will do my best to:
BE CLEAN IN MY OUTDOOR MANNERS
I will treat the outdoors as a heritage to be improved for our greater enjoyment. I will keep my trash and garbage out of America's waters, fields, woods, and roadways.
BE CAREFUL WITH FIRE
I will prevent wild fire. I will build my fire in a safe place, and be sure it is out before I leave.
BE CONSIDERATE IN THE OUTDOORS
I will treat public and private property with respect. I will remember that use of the outdoors is a privilege I can lose by abuse.
BE CONSERVATION-MINDED
I will learn how to practice good conservation of soil, waters, forests, minerals, grasslands, and wildlife; and I will urge others to do the same. I will use sportsmanlike methods in all my outdoor activities.
BOY SCOUTS OF AMERICA

Awards for Boy Scout Conservation Efforts

The United States Departments of Agriculture and Interior will make individual and unit awards to Boy Scouts who participate in the Boy Scout good turn conservation program for 1954 which began officially on March 21.

Twelve scouts who make outstanding contributions to the program will be selected to receive certificates of National Conservation Achievement. The certificates will be presented to the scouts by President Eisenhower when they report to him during Boy Scout Week in 1955. President Eisenhower, a member of the Boy Scout Executive Board, suggested the conservation effort to the scouts.

All units actively participating in the good turn program will receive a certificate signed by the Secretary of the Interior and the Secretary of Agriculture.

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of America, *past president and fellow of the Soil Conservation Society of America,* past vice-president of Section O and fellow, American Association for the Advancement of Science, and past chairman of the National Joint Committee on Grassland Agriculture. In the summer of 1952 he was chairman of one section of the International Grassland Congress held at State College of Pennsylvania.

He is also a member of the American Chemical Society, the American Society of Plant Physiologists, Phi Beta Kappa, and Sigma Xi. The Philadelphia Society for Promoting Agriculture awarded him a medal as an "eminent agronomist" in 1952. His name is listed in American Men of Science and Who's Who in America.

Two textbooks have been written by Dr. Bear. They are *"Theory and Practice in the Use of Fertilizers,"* now out of print, and *"Soils and Fertilizers,"* now in its fourth edition. He is the co-author of three other books and of many bulletins, circulars, and journal articles, both scientific and popular. Many of this country's best known soil scientists have taken their advanced degrees with Dr. Bear or have worked under his direction.

Goodyear Awards Program

Art Morrill, director of the Goodyear Soil Conservation Awards Program for the past three years, has transferred to the Goodyear Export Company. A. H. Settle will succeed Mr. Morrill as director of the Awards Program which is a competitive program for soil conservation districts and is now nation-wide in scope. Entries for the current year closed on April 30, 1954 and districts have until May 15 to submit their score sheets.

"Training the Conservation Worker" Reprint Available

A reprint of the symposium *"Training the Conservation Worker"* conducted during the 1953 meeting of the American Institute of Biological Sciences at the University of Wisconsin is now available. The conservation project is a part of the program of the National Association of Biology Teachers.

Copies of the reprint may be obtained from Dr. Richard L. Weaver, Conservation Project Leader, P. O. Box 2073, Ann Arbor, Michigan. The reprint sells for 10c each in quantities of less than 200,000, for 4c each if a greater number is ordered. It carries brief papers on: *"Resource Management Emphasis in Training Technical Foresters"* by O. F. Hall, University of Minnesota; *"Training in Wildlife Management"* by Robert A. McCabe, University of Wisconsin; *"Preparation for Fishery*

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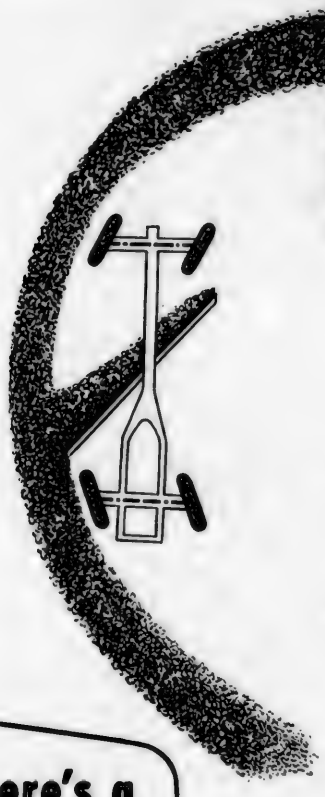

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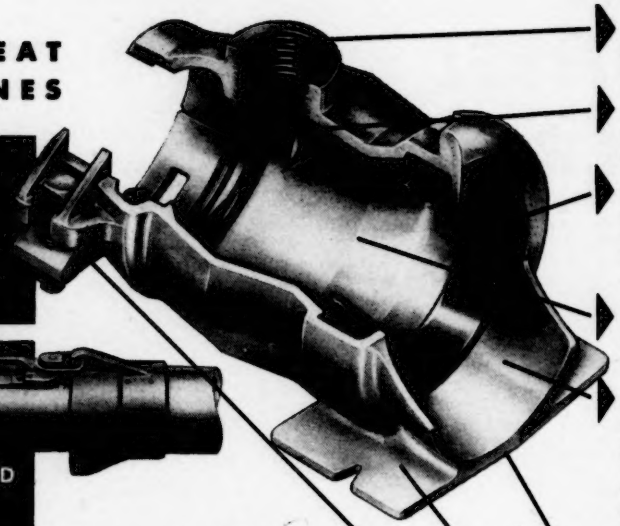

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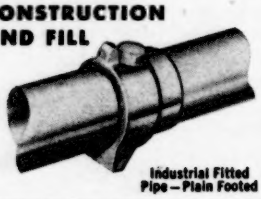

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Research and Management" by Karl F. Lagler; "*Necessity for Background Information in the Training of the Conservation Worker*" by William H. Marshall, University of Minnesota; "*Preparing Teachers of Conservation*" by Richard L. Weaver, University of Michigan.

Crop, Soil Scientists to Meet

The 1954 meetings of the American Society of Agronomy and the Soil Science Society of America will be held at St. Paul, Minn., November 8 to 12, it has been announced by C. J. Willard and Emil Truog, respective presidents of the two societies.

It had been planned previously to hold the meetings at Minneapolis, Minn., during the week of October 25. Certain difficulties in making final arrangements, however, resulted in cancellation of previous plans and in shifting the sessions to St. Paul.

Headquaarters of the 1954 convention will be at the Saint Paul Hotel, with tentative arrangements calling for most soil meetings to be held at this location. Crop science sessions have been tentatively scheduled for the Lowry Hotel, while agronomic education meetings are to be held in the St. Francis Hotel.

Graham on Leave

Dr. Edward H. Graham, first vice president of the Soil Conservation Society of America, has been granted a leave of absence from the Soil Conservation Service, where he is director of plant technology, for several months professional study abroad. He and Mrs. Graham left New York April 19 by air for Lisbon. They will do field work in Algeria, Egypt, Lebanon, Syria, Turkey, Greece, and Italy.

The purpose of the trip is to undertake study and observations of land-use problems and accomplishments in these ancient lands of the Old World. Attention will be given to agricultural, forest, range, and wildlife work, especially its vegetative aspects.

The Grahams will also attend the Eighth International Botanical Congress at Paris in July and the Fourth General Assembly of the International Union for the Protection of Nature at Copenhagen in August. Dr. Graham will present papers and officially represent the Soil Conservation Society of America at these meetings. They plan to return to the States in mid-September.

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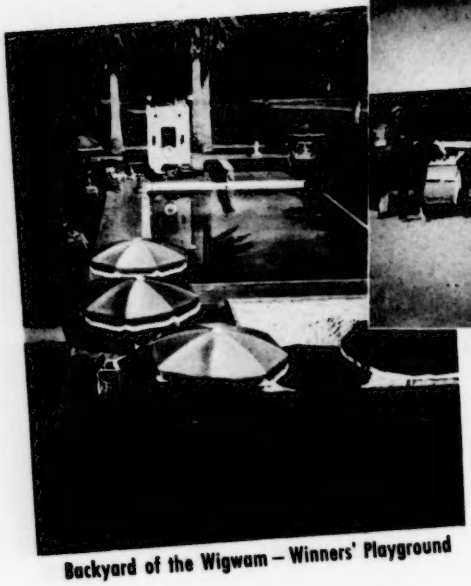

Backyard of the Wigwam – Winners' Playground

Winners Ready for a Morning Gallop

Winners Meeting a Desert Old-Timer

Second Year of Goodyear's National Soil Conservation Awards Program Starts Rolling This Month!

FOR MANY YEARS, Goodyear, through its Farm Tire Department, has warmly supported soil conservation. Back in the '40's, Goodyear added its Soil Conservation Awards Program—which was so well received and so enthusiastically carried through that, last year, the program was expanded to national scope.

Now, 100 winners from all 48 states enjoy all-expense-paid vacations at The Wigwam, Goodyear Farms, at Litchfield Park, Arizona.

Each winner is given western clothing on arrival (which he may keep as souvenirs) and the fun-packed program includes swimming, horseback riding, golf, mountain and city tours, a desert barbecue, illustrated talks, movies—and inspections of Goodyear Farms operations.

Other awards include handsome bronze plaques to 100 soil conservation districts—and framed Certificates of Merit to outstanding farmers or ranchers in each enrolled district.

All soil conservation districts in continental United States may compete – and there's still time to get in. For further details without obligation, see your local soil conservation district office, your country agent – or your nearest Goodyear Farm Tire Dealer.

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